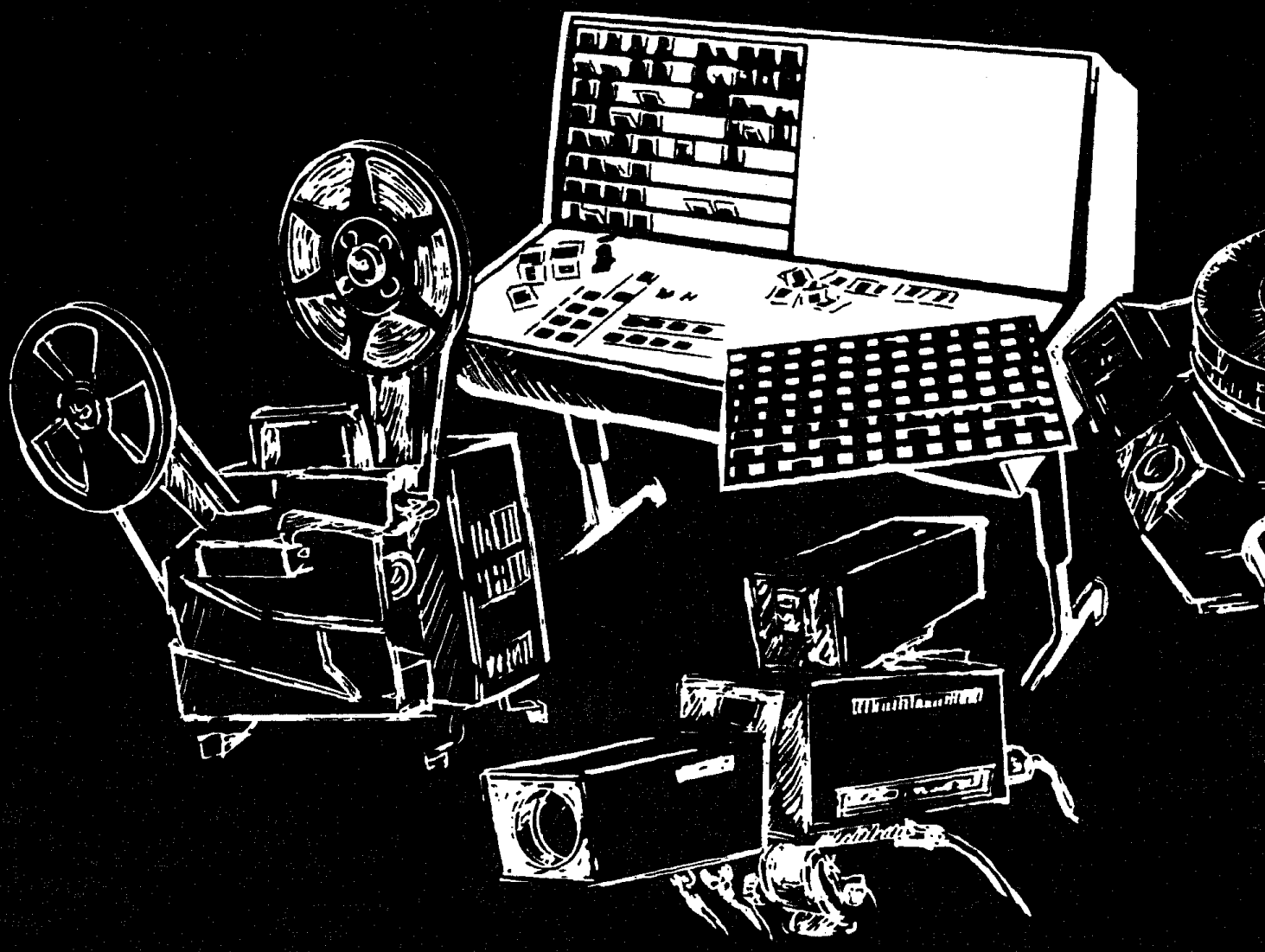
# NAVY PHOTOGRAPHER'S MA TRAINING SERIES



## AUDIOVISUAL PRODUCTIO QUALITY ASSURANCE A SPECIALIZED PHOTOGRA

Although the words "he," "him," and "his," "she," "her," and "hers," are used sparingly in this manual to enhance communication, they are not intended to be gender driven nor to affront or discriminate against anyone reading Module 4, *Audiovisual Productions, Quality Assurance and Specialized Photography*, NAVEDTRA 373-04-67-83.

Naval Education And Training Program Develo

# NAVY PHOTOGRAPHER'S MA
# TRAINING SERIES

## MODULE 4

## AUDIOVISUAL PRODUCTIONS, QUALITY A
## AND SPECIALIZED PHOTOGRAPH

## NAVEDTRA 373-04-67-83

*1983 Edition Prepared by*
*PHCM Tom Regina*

# PREFACE

Module 4, *Audiovisual Productions, Quality Assurance and Specialized Photography* is one of the textbooks in the Navy Photographer's Mate training series. This manual was written especially for the men and women of the Navy and Naval Reserve.

Module 4 is a source of information on:

- *Audiovisual Productions*—The methods of producing AV presentations. Some of the subjects covered include: production planning, script writing, directing, and audio, slide, motion, TV, and multi-image productions.

- *Quality Assurance*—The methods and techniques of photographic process quality assurance for both black and white and color photography.

- *Tactical Air Photographic Reconnaissance*—The methods and procedures of planning and carrying out various aerial photographic missions.

- *Specialized Photography*—Various specialized photography areas are covered with the aim of giving senior PHs the knowledge necessary to carry out their responsibilities in teaching and supervising both photographic and nonphotographic personnel in the performance of specialized photography. Some subjects covered include: underwater photography, cold and tropical weather photography, submarine periscope photography, and cathode-ray tube photography.

An NRCC (Nonresident Career Course) is included in this module. Information on course administration is available in NAVEDTRA 10061.

This module was prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training.

Your suggestions and comments on this module are invited. Address them to the Commanding Officer, Code PD, NETPDC, Pensacola, FL 32509.

1983 Edition

**Stock Ordering No.**
**0507-LP-373-0400**

Published by
NAVAL EDUCATION AND TRAINING PROGRAM
DEVELOPMENT CENTER

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON, D.C.: 1983

# THE UNITED STATES NAVY

## GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

## WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

## THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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# SUMMARY OF PHOTOGRAPHER'S MATE TRAINING SERIES

## MODULE 1

*Naval Photography,* NAVEDTRA 373-01-00-81—A photographic history of the PH rating showing the role played by naval photographers from 1850 to the present; the present mission of naval photography; and a photographic look at present, typical, billet assignments.

## MODULE 2

*Still, Motion Picture, and Television Photography,* NAVEDTRA 373-02-45-83—A complete look at principles associated with photography such as light, optics, cameras, and equipment which the PH must be familiar with to make practical application of the procedures and techniques. The subjects covered include: location photography, portrait and studio photography, television and motion picture photography, and aerial photography.

## MODULE 3

*Laboratory Procedures, Processing and Printing B&W and Color Materials,* NAVEDTRA 373-03-45-83—This module covers the principles of processing and printing black and white and color materials. Some of the areas covered include: laboratory procedures, processing and printing color photography, machine processing, basic maintenance techniques for photographic equipment, and photographic supply and accounting.

## MODULE 4

*Audiovisual Productions, Quality Assurance and Specialized Photography,* NAVEDTRA 373-04-67-83—This module brings to the reader some of the more advanced fields of naval photography. The subjects the reader will encounter include: slide presentation, motion picture and television production, quality assurance, planning aerial missions and specialized photography.

## MODULE 5

*Photographic Management,* NAVEDTRA 373-05-69-82—The methods and techniques of managing a photo lab including budget planning, lab organization, assignments and rotation of personnel within the unit, customer relations, and getting the job done.

# CREDITS

The Naval Education and Training Program Development Center is indebted to a number of organizations and individuals for their assistance during the production of this module. While it is impossible to provide a complete listing of all the contributors, these deserve special mention for their critical review and contributions to the organizations of Chapter 2, Quality Assurance.

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PHCM Tom Regina, USN

An attempt has been made to give credit for each photograph used in this text. Where the photographer's name is known it appears with the picture.

# A REQUEST TO OUR READERS

If you have high quality photography of any subject typically covered by Navy photographers, or photographs of historical interest, or photographs that could be used to illustrate technical aspects of this text, that you would like to see appear in the future editions of this module, or other modules in this series, please write us at:

NETPDC, PD-10, PENSACOLA, FL 32509 Attn: PH RTM Writer

If you don't have any extra copies of the photography, we can arrange to have duplicates made here and will return the originals to you. Please include complete caption information in order that you can be given credit for the photography.

# CHAPTER 1

# AUDIOVISUAL PRODUCTIONS

Audiovisual productions are usually produced to solve a particular problem or to convey certain information. Your interest in audiovisual productions, be they motion picture films, multi-image, video, audio recordings, etc., is in presentations that satisfy a specific communication requirement for your client—the person or organization requesting the production.

Knowing how to make an audiovisual (AV) production or how to use the various media to communicate a message is not enough if you are to be successful. You must also know how to *communicate* with the people who need the presentation—that is known as marketing. Your marketing begins with a sensible look at what you have to offer, and AV productions are not what you have to offer. What you have to offer, through AV productions, are solutions to problems—using some form of AV productions as the medium for communication.

## PLANNING AV PRODUCTIONS

In this section we will limit our discussion to the planning and writing requirements for AV productions in general. In later sections of this chapter, we will expound on each of the various media: motion picture, multi-image, video, audio, etc., and we will again touch on planning and writing as it applies specifically to each. For now, however, one of the most important factors for you to remember when developing any AV production is to be flexible. Flexibility is necessary on the part of both the client and producer in planning and beginning production on a successful product.

### THE AUDIENCE

Audiovisual productions are made to be presented to an audience. The intent of a production is usually to give the audience information, teach them something, or to change their actions or attitudes. But, even in today's "information age," audiovisual producers and clients often operate from within an informational vacuum—thus failing to determine the audience's needs, their knowledge, their wants or need to learn, whether they are recruits or old salts, enlisted or officers, young or old, junior or senior, etc.

Too often we are guilty of answering the question, "Does this audiovisual presentation help communicate the intended message?" with an "I don't know, but that's how we did it on the ship," or "I hope so," or "I guess so" type of responses.

As an AV producer, you will serve as a consultant to your client. By asking the client about the intended audience, you will get the *client's* viewpoint—which may or may not be the concerns, needs, and knowledge of the audience. Thus the presentation may not be appropriate for the audience and it will fail to communicate the desired message. By doing some basic research during the preproduction process, a good deal of value can be added to the production. The client can be assured that the presentation hits home with the audience. And because the research requires cooperation between the producer and client, a better relationship is formed.

As the producer, you also place yourself in a can't-lose situation. If the research contradicts the client's original conceptions, you will have saved the Navy from an expensive blunder. If the research substantiates the client's early views, then the client appreciates your confirmation of his ability to understand the audience.

Basic AV production research need not, and should not, be a complex psychological analysis taking weeks to implement and even longer to analyze. The research should be a simple effort to understand the audience. Some questions to be

- What does the audience want to experience, what do they want to know, what do they want to learn, what attitudes or actions do they want to change?

- Does the audience want information, knowledge, or entertainment?

- Does the audience feel good about themselves, the Navy, their command, their work, or is there a morale problem?

- Are they well informed about the issues affecting their work, their ship, their training, etc.?

- What is their opinion about past presentations of the type to be produced?

- Are they attending the presentation enthusiastically or reluctantly?

- Why are they attending?

Analysis of the audience is usually continued and interwoven with defining the production objectives, as well as each successive step in the planning process.

## OBJECTIVES

Preplanning an audiovisual production must include determining the desired outcome and then writing well-defined, clear objectives to meet that goal. Well-written audiovisual communication objectives, besides defining the outcome, should answer the basic question, "Why do we need an audiovisual presentation (film, multi-image, video, etc.,) in the first place?"

An objective is a statement of need and solution. It is a statement of outcome that is measurable. It should "nail down" the usefulness of the proposed AV production, and it must serve as a *guideline* throughout the production process.

Before you start an AV production, ask yourself this very important question, "What are the communication objectives?" Many of us begin the production. That purpose should be framed in an objective—a statement or statements of what the presentation's effect will be on the audience. In other words, what will or should the audience do or be able to do after seeing the presentation.

In writing objectives for an AV presentation, you should always state the goals in terms of some change in human behavior. The objectives should always include statements such as "be able," "demonstrate an ability," "to ask," "to order," "to recognize," "to determine," etc.

Writing communication objectives should not be simply a matter of describing the presentation's content or theme. To say that you want "to show the features and benefits" of a new warship is not a communication objective, or at best is an ambiguous objective. Ambiguous objectives can be costly because you and the client may be thinking different thoughts even when you're saying the same words. For example, a multi-image presentation developed to help celebrate the bicentennial of our Navy might have as its objective "A description of the importance of the Navy in the development of world trade." That objective and that multi-image production *might* work, *unless* the finished product gave the impression that sea commerce is old-fashioned. If it did, you can be sure that the presentation will never be seen by the intended audience. The same proposed presentation might have a much different perspective if the objective were: "After viewing this presentation, sailors will be able to answer questions about the Navy and have a better understanding of the Navy's role in developing and maintaining world commerce through the use of our modern warships." This differs greatly from "a presentation about the importance of the Navy in the development of world trade."

You need to realize that different people will often see the same thing from different perspectives. That's why you must always write clearly stated communication objectives before you start any AV production.

## OUTLINE

Once you have established your objectives, you can prepare an outline of the proposed

tation. Keep the outline simple and limit it to a concise summary of those major points and supporting facts that will lead to the

In writing the outline, plan the logical "flow" as well as the content of the major points.

OUTLINE

1. Opening titles
   a. Official standard title
   b. Production title
2. Introduction sequence
   a. View of NAS from the air
   b. Various shots of NAS landmarks
   c. People walking about streets
3. Shots of historical documents and plot maps from the 1800 era of the NAS
   a. Black and white copies of old photos
   b. Portraits of COs in their 1800 style uniforms

17. New modern ships entering harbor
    a. CV
    b. DDG
    c. LCC
18. New modern A/C
    a. F-14A
    b. F-18
    c. C-9

27. Closing shots of NAS from the air

From time to time throughout the planning stages of a production, you should review your progress. It is much easier to make changes during the early stages rather than later during production.

The story treatment is a "word picture" of the proposed presentation and is usually written in the form of a scenario of the production. At this time you must make decisions, if they haven't been made previously, about the prevailing mood and overall treatment of the production content. Is the production to have a humorous treatment using cartoons and light, comic narration? Or content will have an influence on its effectiveness.

You will benefit from an explicit story treatment. A detailed, written treatment will help you and your client know what to expect from the finished production—both how much and how little. With the specifics in writing, you can itemize your equipment needs, manpower, talent, sets, and any number of other requirements.

Story Treatment

First Sequence

The presentation opens with shots of a C-12 aircraft approaching NAS Pensacola and moves into the cabin for a close-up of a passenger at a window seat. He is the "Gray Eagle" coming home to where he received his flight training so many years ago. He looks down at the approaching air station. We see the air station, subjectively, through his eyes, beginning with distant views (LS) then zeroing in on familiar landmarks (MS) and buildings that get his attention.

The narration commences, expressing the Gray Eagle's thoughts—general in nature at first. "My old air station—the place where it all began." The narration becomes more specific and begins to set the stage for a discussion of NAS Pensacola's role in our modern Navy. We now go to shots of the following landmarks:

- The Naval Air Rework Facility. This is an area of the air station about which he knows very little except . . . would have opened up new.
- A new modern BOQ. Then a shot of the Eagle's eyes, there is a sudden shift in pace and mood, the camera turns to the Gray Eagle's old barracks where he lived with all those other early Naval Aviators. He is proud and pleased he had to "tough it out" in a dorm that didn't even have air conditioning or heat. As we . . . of the swimming pool.

Second Sequence

We leave the plane's cabin to show the C-12 on final approach to the runway and transition to shots of artwork (old B&W photos) of how NAS Pensacola looked from the air in those early years. We pick out . . . came naturally . . .

Third Sequence

We return to the 1920s—very quick, candid shots of student pilots . . .

Fourth Sequence

Examples follow to show . . . taxpayer dollars.

- Hangars: It takes the . . . larger plants?
- Runways: Expenditures are rising faster . . . this effort will benefit the entire nation.
- . . .
- . . .

Narration concludes with a forecast of . . . responsibility. Narrator says, "If not you, who? If not now, when?"

## STORYBOARDING

A storyboard or planning board is a simple tool that is essential in the initial steps of planning and organizing an audiovisual presentation. When you plan a major production, several storyboards may be needed. A modest production can usually be organized on a single board.

### Planning Cards

Planning cards are arranged on the storyboard in story sequence. They should remain visible to be previewed, studied, and rearranged as needed.

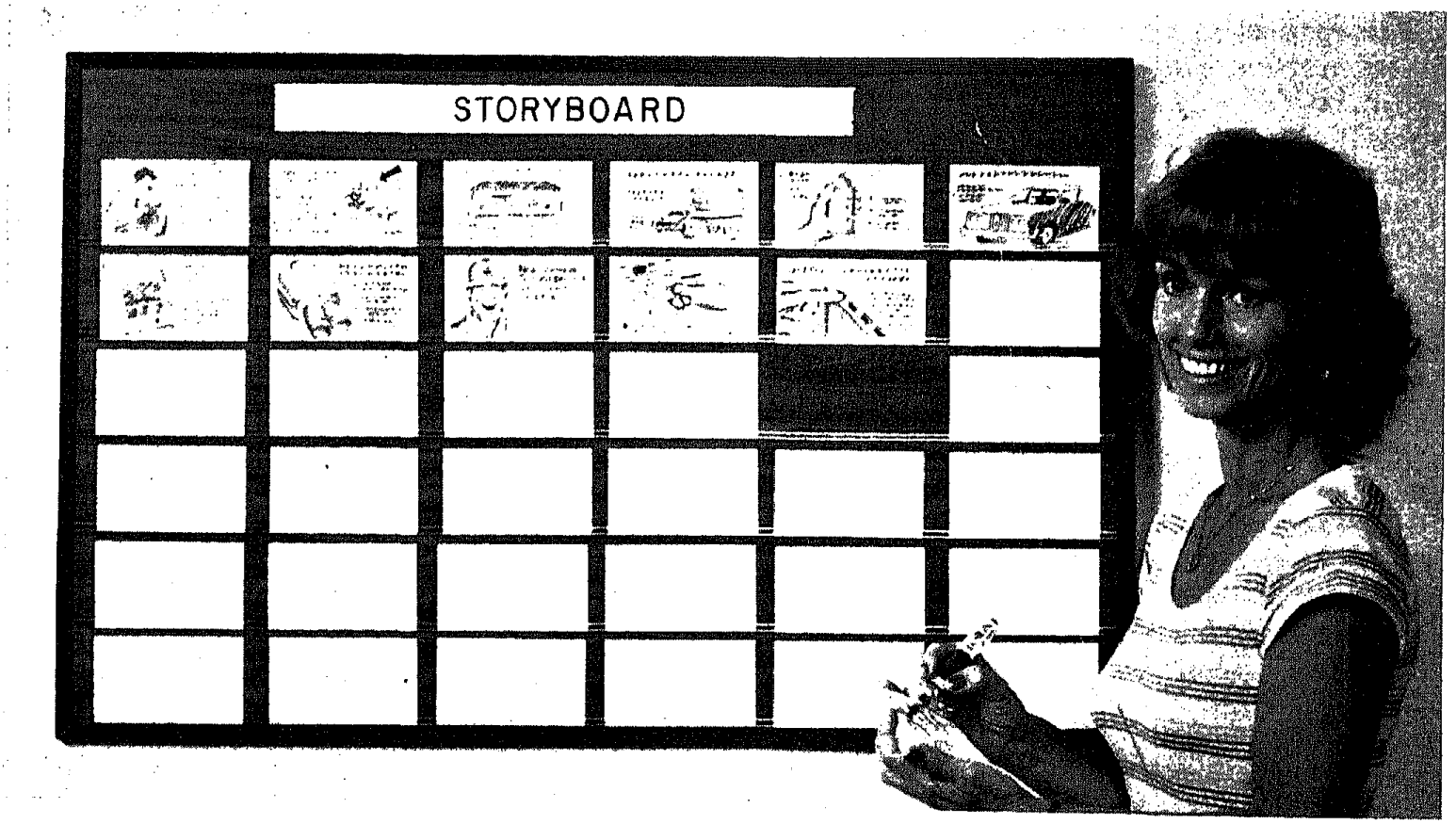
The way to start your storyboarding is to write on a plain white 3 × 5 index card one idea or point that you want to include to achieve a defined objective. Put this first planning card on the storyboard, then write another idea on another card, place it on the board. Repeat the process, putting each card on the board in story continuity sequence, until no more ideas come to mind.

If more than one person is involved in the storyboarding, and well there should be, the brainstorming method is used. Every idea or thought, no matter how unlikely it may seem, is written on a card and placed on the board in story sequence.

The next step in storyboarding is to rearrange the planning cards into a logical, smooth-flowing sequence. At this stage, new ideas may be added or some of the original ideas deleted or changed. This is called storyboard editing. Cards with similar or overlapping ideas are arranged or grouped together. Ideas that are not practical or are inconsistent with the stated objectives are pulled from the storyboard but not deep-sixed—you may need to refer to them later. As new ideas come to mind, they are added to the board in their proper sequence location. Finally, the cards are arranged to represent the continuity or flow of the ideas to be presented in the completed production.

### Storyboard Cards

Once you are satisfied with the content and arrangement of the planning cards on the




*Courtesy Shoss and Associates, Inc.*

PRODUCTION NOTES:

NARRATION:

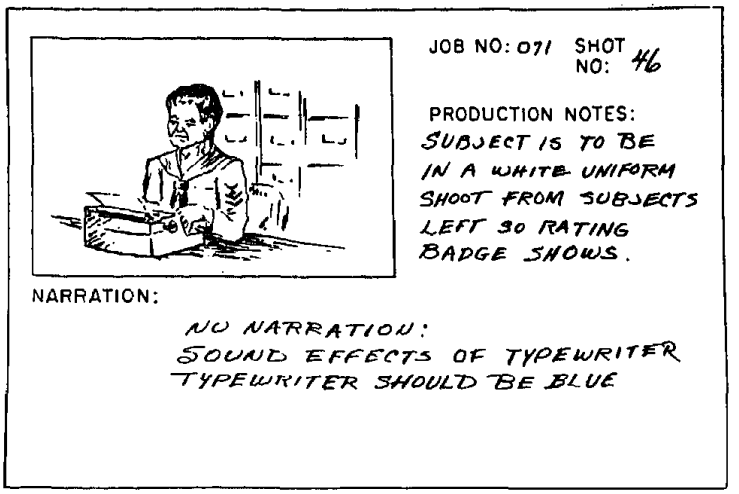
narration or dialogue for the anticipated shot; however, this is not usually necessary since this information will be included in the script.

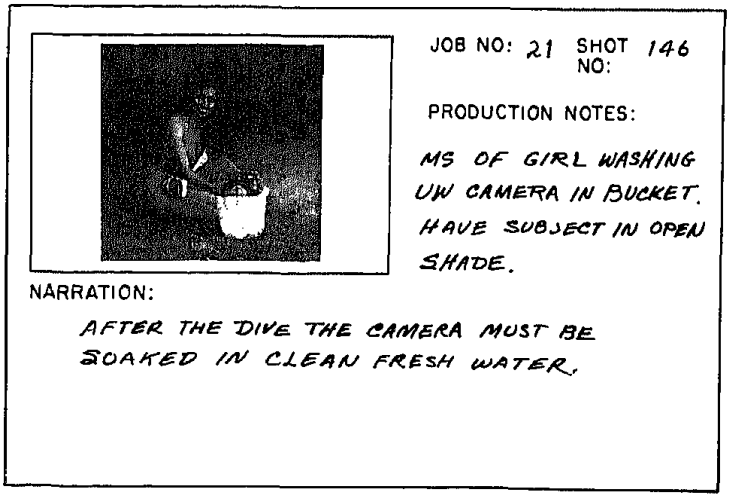
The storyboard is your blueprint for writing the script. It is a set of guidelines that will aid you in visualizing the production's stated objectives. A well-done storyboard will help you determine the best sequence and pace of the program to make sure each objective has been achieved.

storyboard, the next step is to incorporate the planning cards into storyboard cards.

Storyboard cards will be used to visualize in detail the ideas written on the planning cards.

Storyboard cards can be produced locally and duplicated in quantity. If large numbers are needed, it may be practical to have them printed either in the printshop or commercially. These cards are usually 3 × 5 inches. A suggested format is shown above. The upper left section of the card is an area for a rough sketch of the anticipated shot. It's always a good idea to visit the shooting location before sketching the visuals. Location photos can be attached in the graphic area of the storyboard card. The other information to be entered on the card is:




- Job Number—The number or title of the production.

- Shot Number—The entry here indicates the presentation sequence of the slide, scene, shot, or artwork, etc., in the production. Always mark the illustration/shot number in pencil to begin with, then re-mark in ink after the final sequence is determined. Changes during storyboarding can be made by renumbering, deleting, or adding cards as needed.

- Production Notes—This area is used for notes on such things as whether the visual requires location or studio shooting, artwork, special equipment, techniques, etc. Other things which may be indicated here may include background color, lettering style, camera angles, etc.

## SCRIPTS

A script, often described as the producer's blueprint, is the working plan used to translate an idea into an audiovisual production. More specifically, the script is a detailed guide of the

be spoken, and the camera angles that will be used for the production whether it is a 1-minute television video spot, a 20-minute multi-image show, or a 2-hour motion picture drama. Most professional producers and photographers agree that a well-planned script will usually result in a better presentation—one produced with maximum skill and minimum time and expense.

The script examples shown in this chapter serve as examples only. Our intent is not to say that all scripts should follow the style and format presented here. What we want you to do is apply the information to your scripting so that your scripts will be complete and usable as a "map" of production.

## TECHNICAL ADVISOR

The technical advisor is responsible for providing the scriptwriter with technical details which will translate into the production scenario. As a scriptwriter, you may be totally unfamiliar with the technical specialty of the production technical advisor to give you all of the pertinent information relating to the production *subject*.

While the technical advisor is a specialist in his particular field, you, as the scriptwriter, must also be a specialist in your field, adept at gathering information, expressing ideas in words, and adapting and converting raw data into audiovisual production scripts.

You must have the specialized information which only the technical advisor can provide. The material which the advisor conveys to you may come from training manuals, evaluation reports, fact sheets, technical papers, and other documents, as well as from his own personal experience in the technical specialty. Only the technical advisor has the expertise to extract the relevant details from these publications and from his own experience.

### Script Research Material

An example of acceptable research material with artwork submitted to a scriptwriter by a technical advisor is shown here:

Technical Advisor's Research Material

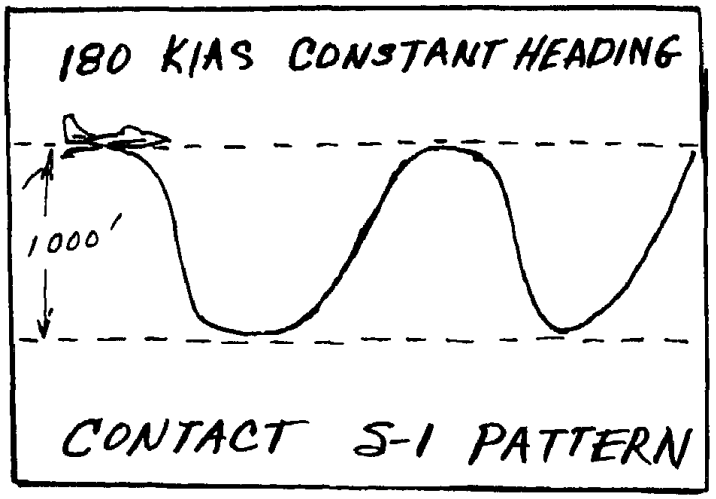
T-2 Basic Instruments Contact S-1 Pattern

Page 1 of 27

Date: 30 Oct 1983

Draft Number: 1

| What We Want To Show | What We Want To Say |
|---|---|
| (Visual) | (Audio) |
| Live action photography of the T-2 airplane in the process of performing the S-1 Pattern. This should probably be shown from the side in order to see the S-1 Pattern more clearly. | Introduce the subject; identify the airplane and what it is doing—performing the S-1 Pattern. |
| No bag (opaque canopy cover used to teach instrument flying) on the cockpit. | |
| At this point we should use artwork to show the entire S-1 Pattern with drawings of the aircraft starting the descent phase, then progressing through the climb phase. | Tell what the Contact S-1 Pattern consists of: a descent rate of 1000 feet per minute, followed by a climb of 1000 feet per minute. |




The pattern is completed by repeating the descent and climb phases. Entire pattern is flown at 180 knots indicated airspeed on a constant heading. Most of the scan will be outside the airplane during the maneuver.

To clarify and emphasize certain points, there should be captions or labels on the drawings to indicate the altitude, airspeed, and heading used during the maneuver.

Back to live action photography of the T-2 airplane as it completes the S-1 Pattern.

Over this live action sequence, tell how the airspeed is controlled by nose attitude, and rate of descent by power. The 1000 feet per minute rate of climb or descent is determined by referencing the VSI (Vertical Speed Indicator). Unlike the Instrument S-1 Pattern, the clock is not referenced.

As the maneuver is repeated in live action photography, show the instrument panel in the cockpit with CUs of instruments and dials to reflect a pattern cruise at 17,000 feet, then CUs of the tachometer moving from 80% to 72%; the Vertical Gyro Indicator (VGI) moving from 3 degrees nose up to 0.

Reduce power as needed to establish desired rate of descent. At the same time lowering the nose to descending attitude.

In the cockpit and from the pilot's point of view, show the earth as the aircraft moves from level flight into the descent phase.

In the cockpit, show the instrument panel with CUs of the tachometer at 72%, speed 180 knots, altimeter starting to drop, VGI at 0 nose, VSI moving from 1000 feet per minute down and steadying.

In descending, maintain the airspeed by adjusting nose attitude, and the rate of descent by adjusting the power.

The technical advisor should not provide the scriptwriter with voluminous writing. Instead, he should keep the material simple and to the point. Abbreviations can be used, but they must be explained. Although they may be familiar to the technical advisor, you, as the scriptwriter, may not be acquainted with them. The technical advisor, therefore, must explain technical terms.

## ELEMENTS OF A SCRIPT

A good script follows a planned pattern which begins with the original idea for a scenario and ends with an actual word diagram for production.

The main elements of a script are:

- The proposed production (film, slide, video, etc.) treatment statement
- The action outline
- The shot breakdown or shooting order

The script includes such information as scene locations, costumes, camera setups, lighting requirements, props, special photographic and sound effects, etc., necessary to complete the project.

### Production Treatment Statement

The proposed production treatment statement is a brief outline of the content of the proposed production. The statement should contain information about the type of film or videotape, etc., to be used (16mm, Super 8, 35mm, color, black and white, video- and audiotape size, etc.), the proposed length of the production, what type of sound, if any, is to be used, production distribution plans, etc. For example:

**This unclassified motion picture will be shot on Eastman Kodak 16mm Ektachrome EF Film, Type 7242. The finished film will have a projection time of 20 minutes ± 3 minutes. All sound will be of narration by a female. Seven release color prints with official standard titles will be distributed by the Chief of Naval Education and Training to selected "A" schools for showing to students prior to beginning a course of instruction.**

The body of the statement tells the story or outlines the proposed production in terms of photographic techniques. For example:

**Open with a usual shot of a symbol which represents the Navy such as a low camera angle shot of a ship.**

**Narrator addresses herself to a naval battle such as Midway, introducing a situation in which a ship is sank.**

**The audience sees sailors calling for help, abandoning ship, dying, and boarding lifeboats.**

**Narrator introduces another ship on which there is a lookout scanning the ocean for survivors.**

**Continue with more scenes of sailors calling for help, abandoning ship, etc.**

**LS of rescue ship entering port . . . MS of . . . being . . .**

### Action Outline

The action outline is a complete breakdown of the production, and it segregates the story into

voluminous notes on narration or dialogue, or both. If necessary, notes on special effects and photographic techniques required to help portray the drama of the production are included. An action outline serves to tell the story in vivid detail. It describes settings and locales; it defines characters and tells who they are, what they are, what they want, how they go about achieving their goals, etc. It is written simply and presents the essence and theme of the story clearly. The action outline is written in terms of visual picturization of the story.

has the scene or shot descriptions in a column on the left side of the page with the narration accompanying the scene descriptions on the right side. The audio/visual relationship of both picture description and narration must be comprehended if a workable scenario is to be produced by the scriptwriter.

The next example shows how the scriptwriter and artist adapted the technical advisor's research material to the format of an action outline.

ACTION OUTLINE

T-2 Basic Instruments

Contact S-1 Pattern

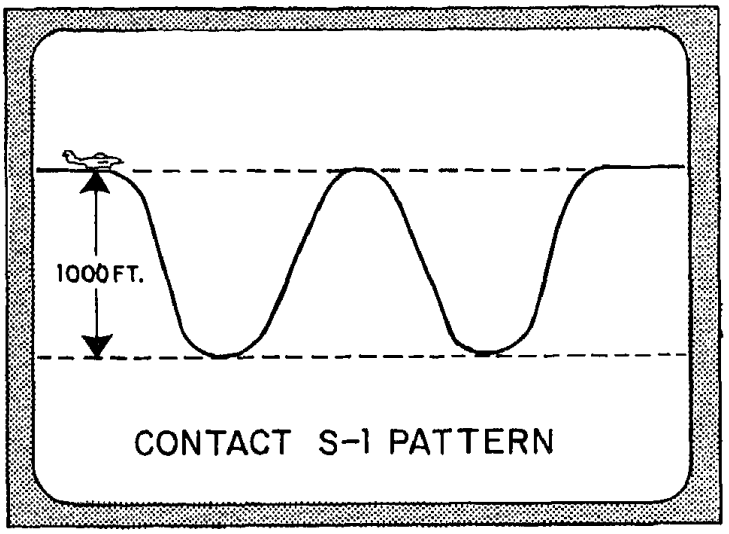
Page 1 of 46

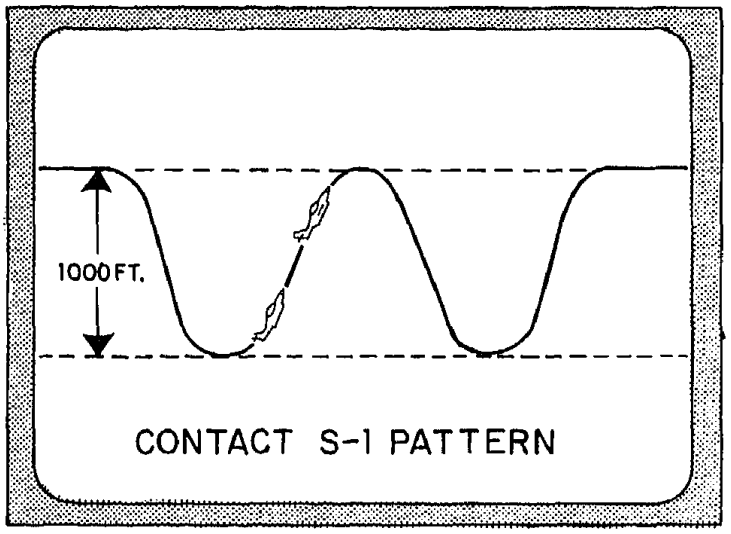
Date: 12 Nov 1983

Draft Number: 2

| Visual | Narration |
|---|---|
| Fade-In | |
| Opening Titles | |
| Fade-Out/Fade-In | |
| 1. Air-to-air: LS—T-2 in process of performing S-1 Pattern. No bag on cockpit. | This film will show the procedures to be used with the T-2 aircraft in performing the Contact S-1 Pattern. |
| Dissolve | |
| 2. Art: Open with entire pattern and label:<br>a. Contact S-1 Pattern.<br>b. Contact S-1 Pattern. Plane (b plane replaces a plane). | The Contact S-1 Pattern consists of a descent of 1000 feet at a constant rate of 1000 feet per minute . . . |

1000 feet at a constant rate of climb of 1000 feet per minute.




4. Art: Continue

a. Pop on[1]: 180 kt label

The pattern is completed by repeating the descent and climb. The entire pattern will be flown at 180 knots indicated airspeed and on a constant heading. Keep in mind that during this maneuver, a good portion of your scan will be outside the aircraft.

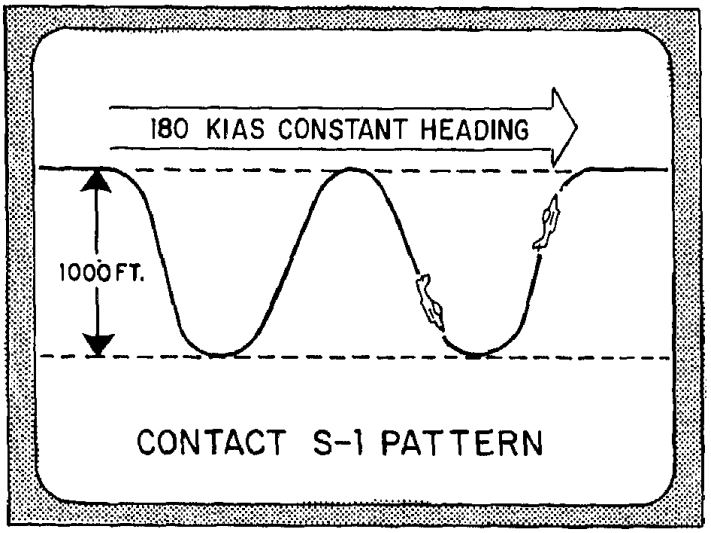
Dissolve

5. Air-to-air: LS—T-2 completing S-1 Pattern. No bag on cockpit. Rolls out to straight and level flight.

During this manuever, your airspeed is controlled by nose attitude and your rate of descent is controlled by power. The 1000 feet per minute rate of climb or descent is determined by referencing the VSI. Unlike the Instrument S-1 Pattern, the clock is not referenced.

[1]Pop on means a visual change; i.e., a new visual "pops" on the screen.

| | |
|---|---|
| 6. Cockpit interior: MS—Instrument console with all readings reflecting pattern cruise at 17,000 feet. | Now, let's see how this maneuver is accomplished. |




| | |
|---|---|
| 7. Cockpit interior: CU—Tachs as they move from 80 to 72%. | Reduce the power as required to establish the desired rate of descent . . . |
| 8. Cockpit interior: CU—VGI as it moves from 3 degrees nose up to 0. | . . . simultaneously lowering the nose smoothly to the descending attitude. |
| 9. Aerial: LS—Pilot POV as A/C moves from level flight into descent. | |
| 10. Cockpit interior: MS—Instrument console. Tachs at 72%, speed 180 knots, altimeter starting to drop, VGI at 0 nose, VSI moves to 1000 fpm down and steadies. | As you descend, maintain airspeed by adjusting nose attitude and your rate of descent by adjusting power. |
| Dissolve | |
| 11. Cockpit interior: MS—Instrument console with all readings as before. Altimeter is moving toward 16,100 ft. Altimeter moves to 16,000 feet. | The transition from the descent to the climb will be started 100 feet prior to the end of the 1000-foot descent. At this point . . . |

**Shot Breakdown**

Another important part of the script is the shot breakdown. Sequential treatment is an important part of every audiovisual production. A sequence is simply a series of related scenes or shots arranged in the proper order of presentation to tell the story. This is usually the most effective way to present a subject and is the order of progression of the action outline. However, it is not usually practical to record a production in sequential order. This is where the shot

is used to realize maximum economy in AV production. It breaks down shots to achieve a minimum number of equipment moves and setups, and to make maximum use of actors and props for the shortest possible time, by cross-referencing scenes in which they are used.

Although you may sometimes be able to record all scenes or shots in the order in which they appear in the action outline, this procedure is usually wasteful. In the shot breakdown portion of the script shown in the next example, shots 28 through 30, 32 through 34, and 54 through 62 are to be made aboard the same ship; the previous, lighting equipment, sound equipment, actors, etc., are assembled aboard the ship and shots 28 through 30 are completed, it is obviously uneconomical to move to another location for shots 31, and 35 through 53; return to the ship for shots 32 through 34; move again for other shots and then back to the ship for shots 54 through 62. It is more economical to make shots 28 through 30, 32 through 34, and 54 through 62 during a single trip to the ship, and assemble the shots in the correct sequence during the editing or assembly phases of the production. A shot breakdown, therefore, coordinates out-of-sequence shooting or recording.

SHOT BREAKDOWN

Welcome Aboard

Page 1 of 4

Date: 12 April 1983

Draft Number: 5

| Shooting Order | Shot/Scene | Location |
|---|---|---|
| 1. | 7, 21-23 | Navy Exchange |
| 2. | 10 | Swimming pool |
| 3. | 1 | Front gate |
| 12. | 40-49 | Naval Station background plate (art) |
| 13. | 2-6 | Titles (art) |
| 14. | 78-84 | Titles (art) |
| 27. | 13, 19, 20 | Admin building |
| 28. | 54-62 | USS Ship |
| 29. | 28-30 | USS Ship |
| 30. | 32-34 | USS Ship |

| | | |
|---|---|---|
| 32. | 35-39 | Sailors working on tugs |
| 33. | 50-53 | Men painting boats |
| 46. | 8-11 | Miscellaneous shots at any convenient time<br>(a) Ocean waves<br>(b) U.S. flag<br>(c) Girls on beach |

**Writing the Script**

Scriptwriting is simply making a "road map" of your AV production. It is the laying out of your route, so to speak, so your presentation reaches its destination or climax successfully. You must figure out this route before you start recording your pictures or sound; otherwise your production will wander about and make many confusing detours.

You will save yourself many wasted hours by coming right to the point and asking yourself the questions:

What? Where? When? Why?

- *What* is the subject?—Get directly to the point and write down specifically, in as few words as possible, exactly what you are going to tell in the production.

- *Where* is the subject?—Where will the story take place? What is the environment of the locations? What are the vantage points from which shots can be made? What conditions exist at the locations that may either contribute to or detract from the quality of the production?

- *When* will the story be shot?—When is the lighting best? What action is involved? When are actors, subjects, and props most readily available?

- *Why* is this production being done?—For what purpose? What should it tell the audience?

Write down the peaks of interest. These are the high points in your production and must come in a logical order. The continuity of your presentation should lead the audience from beginning to end, from peak to peak.

Write down fill-in material. A logical sequence or progression of scenes, shots, dialogue, etc., must build up to each peak or climax of interest. These scenes, etc., must "fill-in" the valleys, so to speak, to prevent lag in the tempo of the presentation.

Picture each scene in your mind. Try to imagine the story as though you were watching or listening to the finished production. When you've "got the picture" draw a rough sketch of the scene.

**Visual Aspect of a Script**

Suppose you are tasked with writing a script for a simple story in which a young sailor is kidnapped from the beach by a bunch of bikini-clad girls and driven off to be held for . . . From this idea you can write a treatment, part of which may read like this: "*The sailor, bound and gagged, is squirming in the back of the pickup truck as it races toward a drawbridge. A boat is due and the kidnappers are desperately trying to beat the boat as the shore patrol, in another truck, is catching up. The gates at the bridge close, the shore patrol's truck roars up, the sailor frees himself and the girls run off to avoid capture.*"

The following outline is one possible treatment of the visual aspect of the script for a motion picture.

ACTION OUTLINE

Kidnapped

Page 1 of 9

Date: 7 July 1983

Draft Number: 1

Visual

1. LS—Sailor lying on beach.

2. LS—Sailor's POV (point of view) of three girls approaching.

3. MS—Sailor's POV of girls approaching.

4. MS—Low angle of girls grabbing sailor.

5. CU—Girls tying sailor's hands.

17. LS—Girls' truck, low angle, right to left. Truck passes quickly through frame.

18. MCU—Shot of girl driving made from outside of truck. Driver looks around to back of truck. As she looks pan to sailor being held down by other girls in back of truck.

19. CU—Sailor's face, gagged, scared.

20. MS—Over driver's shoulder. Road ahead.

31. CU—Driver's eyes. They look down to clock in dashboard.

32. CU—Clock. Second hand moves around. Clock shows 1430.

33. LS—Sailboat travels right to left.

34. CU—Driver's eyes.

35. CU—Rearview mirror with shore patrol truck visible.

patrol truck in pursuit, right to left.

44. CU—Sailor's face, determined, mad. Pan down to hands as they work loose.

45. CU—Girl shifts gears. White knuckles.

46. CU—Girl's face, pan to CU of clock.

47. CU—Clock shows 1431.

48. CU—Shore patrol's face, anxious.

49. LS—Sailboat moving through frame right to left.

50. LS—Flash back to both trucks as they pass quickly through frame side by side.

51. MS—Flash back to sailboat.

52. MS—Flash back to trucks.

53. MS—Flash back and forth very quickly / from boat to

58. truck, boat to truck, . . . to build up tempo and suspense.

61. CU—Sailor's hands finally loose.

62. ECU—Second hand of clock.

63. LS—From across far side of river crossing. Gates close just as truck arrives.

64. LS—Truck stops. Shore patrol just behind.

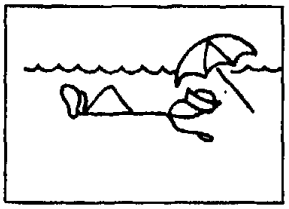
65. MS—Faces of girls in back of truck.

70. MS—Girls jump out of truck.

71. LS—Girls running away.

72. MS—Sailor jumps from truck. Pan with him as he runs to shore patrol truck.

Here is an example of what you might visualize as you write the visual aspects of this script.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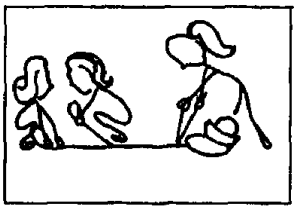
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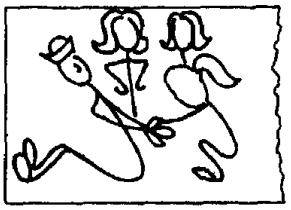
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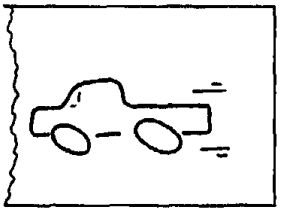
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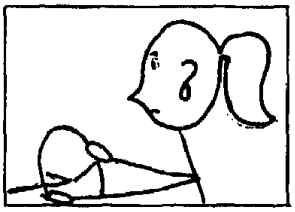
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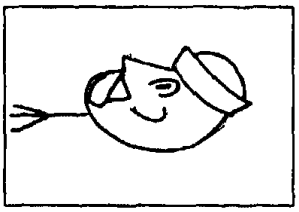
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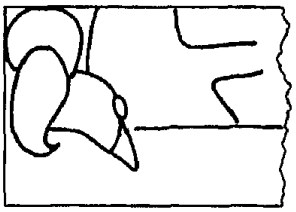
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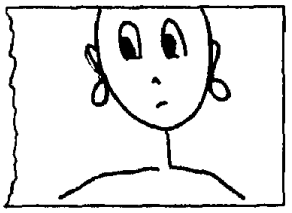
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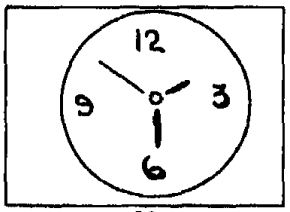

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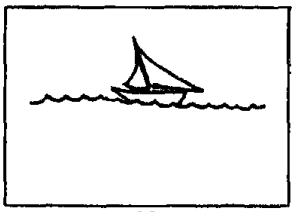
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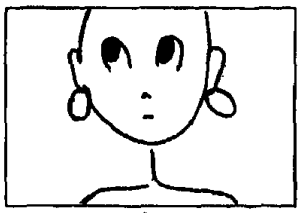
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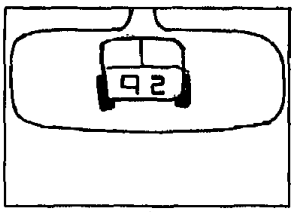
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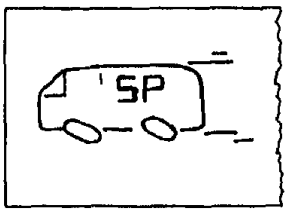

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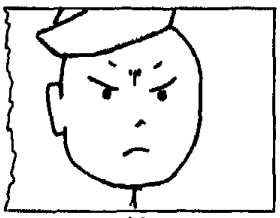
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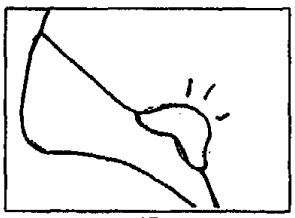
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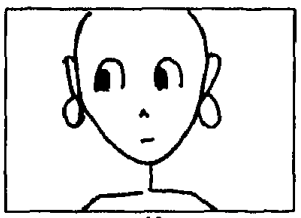
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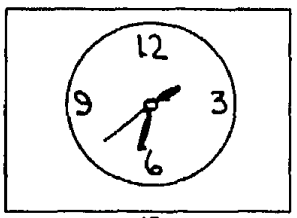

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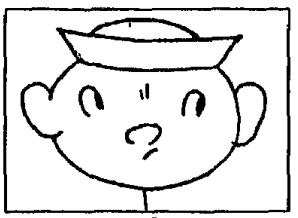
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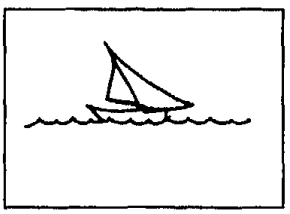
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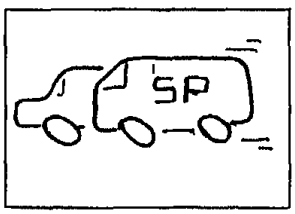

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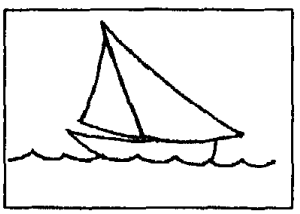
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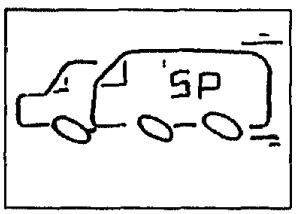

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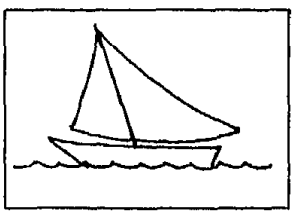
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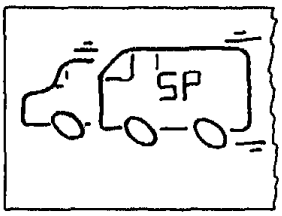

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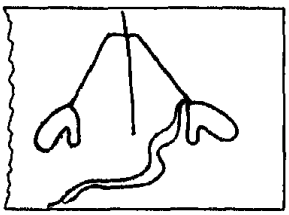
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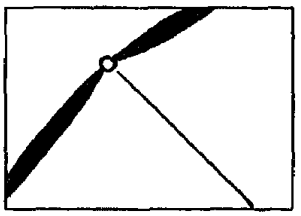
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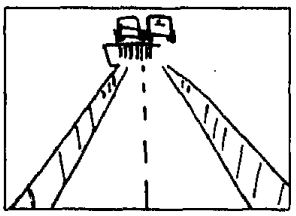
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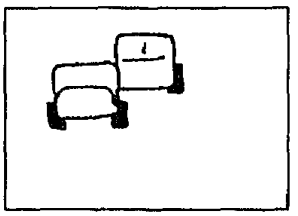
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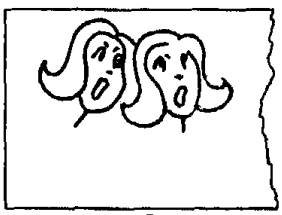
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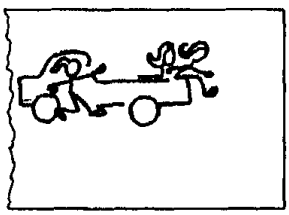
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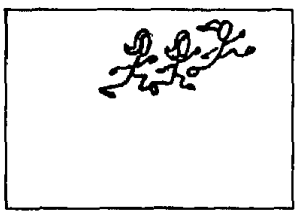
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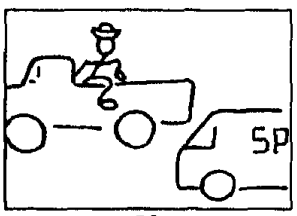

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If Edgar Allen Poe or James Mitchner were around to write the narrative section of your script, it would probably be a classical masterpiece, but since all you have is yourself, you must perform the literary aesthetics and write an effective script that will aid in the accomplishment of your production objectives.

By following a few simple rules, you should find it easy to write effective narration, dialogue, or sound effect requirements. The writing style best suited for use in the narrative section of a script of an audiovisual presentation uses *short* sentences in *conversational* English with *one* key point per sentence.

Suppose Mitchner had written the narration for a script and it was your job to narrate the program. You would find this rather difficult if there were not guidelines to make clear the thoughts of the writer. For this reason, there are three narrative keys which can be used to indicate:

- Emphasis—Where emphasis should be made by the narrator double underlining (_____) is used. Thus: "The men were all assembled on the hangar deck when a mighty wave crashed over the bow of the ship."

- Pause—Where a brief pause should be made, three dots (. . .) are used. For example: "The men were all assembled on the hangar deck when a mighty wave crashed over the bow of the ship. The giant wave that struck the ship . . . caused most of the men to fall."

- Visual change—When the picture or scene on the screen is to change, a C is used to indicate this to the narrator. Thus: "C The men were all assembled on the hangar deck when a mighty wave crashed over the bow of the ship. C The giant wave that struck the ship . . . C caused most of the men to fall."

The main purpose of the narration or sound of an audiovisual presentation is to relay necessary information and aid in program continuity by synchronizing with selected visuals. This is not to say that the style of writing must be dry and basically drab; on the contrary, narrative writing can be both colorful and informative.

you write the narrative for an audiovisual script. The sentences should be *short* and to the point. An abundance of unnecessary words will cause the program to drag on and the audience will lose interest. The sentences should be made up of *conversational English*. This gives the audience a feeling of comfortable communication between themselves and the narrator. The third point to remember is that there should be only *one key point* per sentence. When there is more than one key point in a sentence, emphasis will be lost.

Example: Admiral Byrd had achieved his goal.

The sentence is *short*.
It is written in *conversational English*.
There is *one key point*.

This is not to say that each sentence should contain a main point and the next sentence another point. To the contrary, several sentences can contain the same main or key point. What is important is that good judgment be used when writing the script to maintain continuity.

You should also *avoid* using a steady stream of narration which could become monotonous. When properly placed throughout a narrative, short pauses are very effective tools for attracting and holding the audience's attention.

It is important to note the screen time for visuals is directly related to the narration or sound. The average screen time for a visual should be about 3 to 5 seconds with a maximum of about 8 to 10 seconds in special cases. If a subject is to be covered in great detail with rather lengthy narration, several different views of the subject should be used to shorten the screen time of each visual and hold the audience's interest. The visual and related narrative should be presented simultaneously. Any deviation from this synchronization will cause an uncomfortable feeling among the audience.

The selection of a narrator should be done with care and should be based on voice intelligibility, authority, suitability, and neutral quality. The narrator's voice should be pleasing and relaxing. A test of several voices may be necessary to find the one with the desired qualities.

consideration should be given to the role each will play. The choice of background music can greatly enhance the narrative portions of a presentation. Music, properly used, can create a mood more quickly than any other means of communication. Generally, it takes only a few bars of music to establish a mood. A study of how music is used in television, commercials, and feature films will point out the role it plays in establishing mood.

Music can be used in several ways—alone, as general background; alternately with narration; or, as background for narration. When used with narration, the music is often recorded at a high volume level for sections such as titles, scene transitions, and when action is simple and self-evident. When music is used as a background for the narration or dialogue, it is often more or less continuous and is recorded at a much lower level than the voice. Remember, it is intended as *background* to the narration.

in a wide variety or they can be recorded on location with a portable tape recorder.

The importance of a presentation's introduction and conclusion cannot be overemphasized. It is in the first few seconds of a presentation that the audience's attention is gained or lost, therefore, any music used in the introduction must be dynamic and demand attention. The conclusion is equally important because it serves to reinforce the presentation's key points and increases audience retention of the material presented.

The following example is typical of a script with both visual and narrative presentations. You will notice that in the narrative section the C which indicates a change in visual has a dash (-) and a number following it. This is an option which you may want to use to indicate the number of the visual to which the C pertains.

SCRIPT

South to the Pole

Page 1 of 10

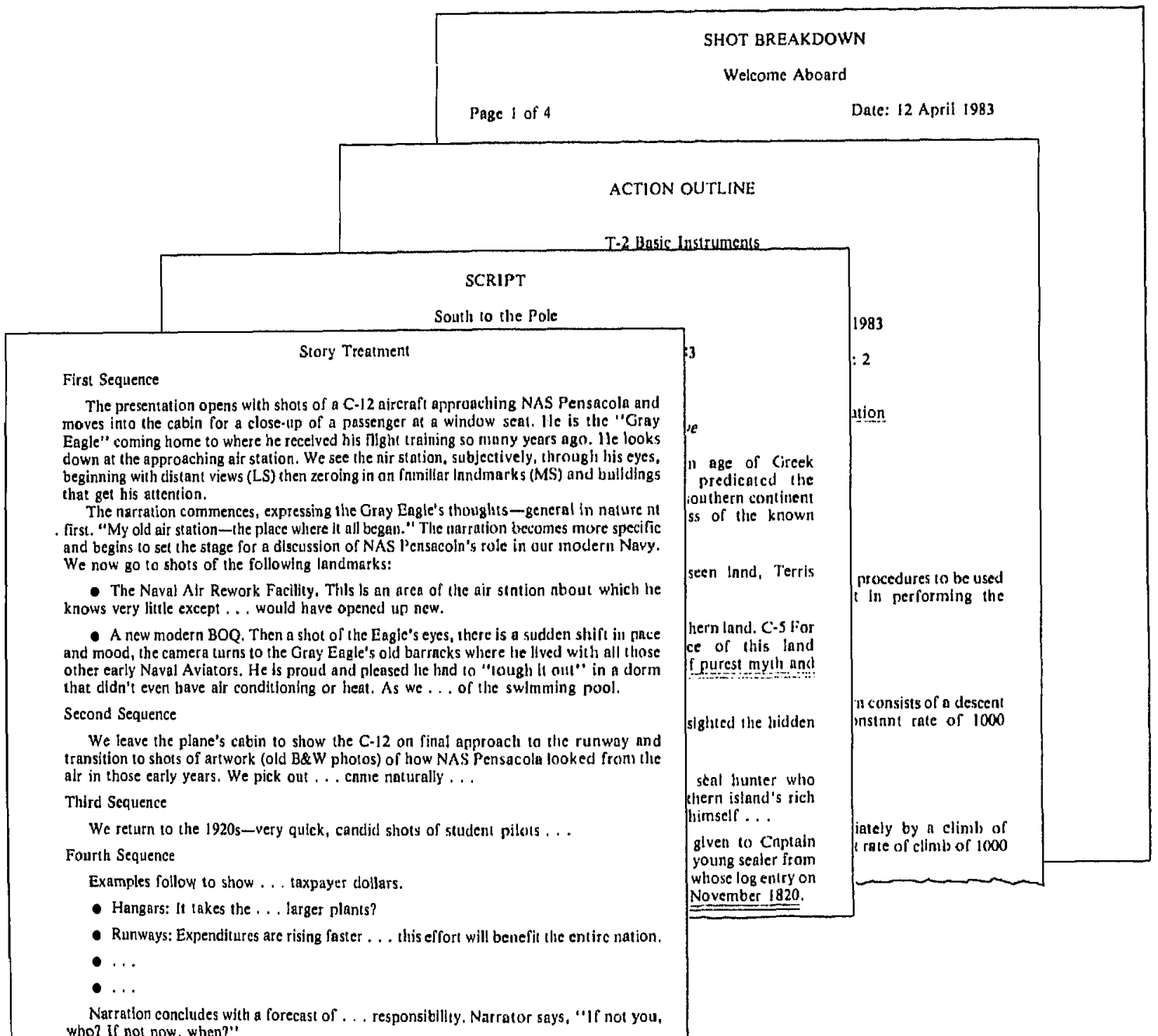
Date: 6 April 1983

Draft Number: 3

| | *Visual* | *Narrative* |
|---|---|---|
| 1 | Title slide | C-1 During the golden age of Greek philosophy, Aristotle predicated the existence of a large C-2 southern continent to balance the landmass of the known northern continent. |
| 2 | MS Bust of Aristotle | |
| 3 | Old drawing of southern continent | C-3 He called this unseen land, Terris Australus Incognita. |
| 4 | Drawing of Aristotle teaching a class | . . . C-4 The hidden southern land. C-5 For centuries, the existence of this land remained the province of purest myth and speculation . . . |
| 5 | Map of world as known during Aristotle's time | |
| 6 | Old drawing of seal hunters and sailing ships | C-6 As to who actually sighted the hidden continent first is unclear. |

| | | |
|---|---|---|
| 7 | Drawing of a seal hunter | C-7 It was probably a seal hunter who wanted to keep the southern island's rich harvest of seal skins to himself . . . |
| 8 | Drawing of Palmer | C-8 Credit is generally given to Captain Nathaneal Palmer, C-9 a young sealer from Stovington, Connecticut, whose log entry on the sighting is dated 17 November 1820. |
| 9 | Drawing of Palmer's ship and crew hunting seals | |

When the technical advisor reviews the script for technical approval, it is imperative that he read the scene description and narration together—across the two-column page from left to right. The tendency on the part of many technical advisors often is to read only the narration. Audiovisual education authorities give primacy to the visual. It carries the greater part of the communications load as expressed in the well-known axiom: "One picture is worth a thousand words."



SHOT BREAKDOWN

Welcome Aboard

Page 1 of 4 Date: 12 April 1983

ACTION OUTLINE

T-2 Basic Instruments

SCRIPT

South to the Pole

Story Treatment

First Sequence

The presentation opens with shots of a C-12 aircraft approaching NAS Pensacola and moves into the cabin for a close-up of a passenger at a window seat. He is the "Gray Eagle" coming home to where he received his flight training so many years ago. He looks down at the approaching air station. We see the air station, subjectively, through his eyes, beginning with distant views (LS) then zeroing in on familiar landmarks (MS) and buildings that get his attention.

The narration commences, expressing the Gray Eagle's thoughts—general in nature at first. "My old air station—the place where it all began." The narration becomes more specific and begins to set the stage for a discussion of NAS Pensacola's role in our modern Navy. We now go to shots of the following landmarks:

- The Naval Air Rework Facility. This is an area of the air station about which he knows very little except . . . would have opened up new.
- A new modern BOQ. Then a shot of the Eagle's eyes, there is a sudden shift in pace and mood, the camera turns to the Gray Eagle's old barracks where he lived with all those other early Naval Aviators. He is proud and pleased he had to "tough it out" in a dorm that didn't even have air conditioning or heat. As we . . . of the swimming pool.

Second Sequence

We leave the plane's cabin to show the C-12 on final approach to the runway and transition to shots of artwork (old B&W photos) of how NAS Pensacola looked from the air in those early years. We pick out . . . came naturally . . .

Third Sequence

We return to the 1920s—very quick, candid shots of student pilots . . .

Fourth Sequence

Examples follow to show . . . taxpayer dollars.

- Hangars: It takes the . . . larger plants?
- Runways: Expenditures are rising faster . . . this effort will benefit the entire nation.
- . . .
- . . .

Narration concludes with a forecast of . . . responsibility. Narrator says, "If not you, who? If not now, when?"

begin by considering the audience, establishing the objectives, and organizing the content, such as storyboards and scripts, to meet the objectives. Interwoven with this is the selection of the method of presentation or the AV medium to be used. Of course, this step may have been decided even before you began your planning. The method of presentation may be dictated by higher authority, and it may be dependent on the resources available. For example, aboard ship an elaborate multi-image staging setup probably will not be available, or 16mm projectors may not be available, or maybe only video monitors are available. As a professional, you will generally be asked to help select the most appropriate medium to present the subject.

How do you go about selecting the most appropriate presentation method or methods? The reason we say methods is that at some time you may be involved in producing a program that will have wide distribution. For example, you may produce a six-projector multi-image show to be used at large naval shore stations and aboard several small ships. Obviously, any six-projector staging may not be appropriate for the ships; therefore, once the multi-image show is complete, you may be able to videotape it for the ship's closed-circuit television system.

In selecting the medium, one of the first things to consider is *what must be communicated.* Only after establishing what it is you want to communicate will you be able to select the most effective channel of presentation through which the objectives will be met.

If motion is inherent, and important to the subject, consider the motion picture media. If motion is not important, then consider other media that require simpler skills, less time, less money, etc., yet do the job just as well. For example, large photographic prints which can be studied in detail may be preferable to a slide presentation—and easier to make. You should also consider using combinations of media. A series of overhead transparencies of charts and graphs can be supplemented with a set of slides and the two used simultaneously for an effective two-screen presentation. Single or combinations

availability, convenience, cost, urgency of the project, etc. But each of the AV presentation methods makes certain unique contributions to effective communications. Before production can begin, all presentation methods require careful planning—some more than others. Before selecting the method to serve your communications goals, look at all of them, become aware of their special characteristics and the specific contributions they can make.

## PHOTOGRAPHIC PRINT SERIES

A photographic print series may be used to convey information, teach a skill, or affect attitudes through individual study, small group viewing, or display. A print series used to teach a skill or for study should include directions for its use. An example is a series of photographs showing how to thread a motion picture projector; the trainee must know where to start and in what order the procedures are to be followed. Print series are very effective as a display to inform, entertain, or motivate viewers. Three important points to observe when preparing a print display are:

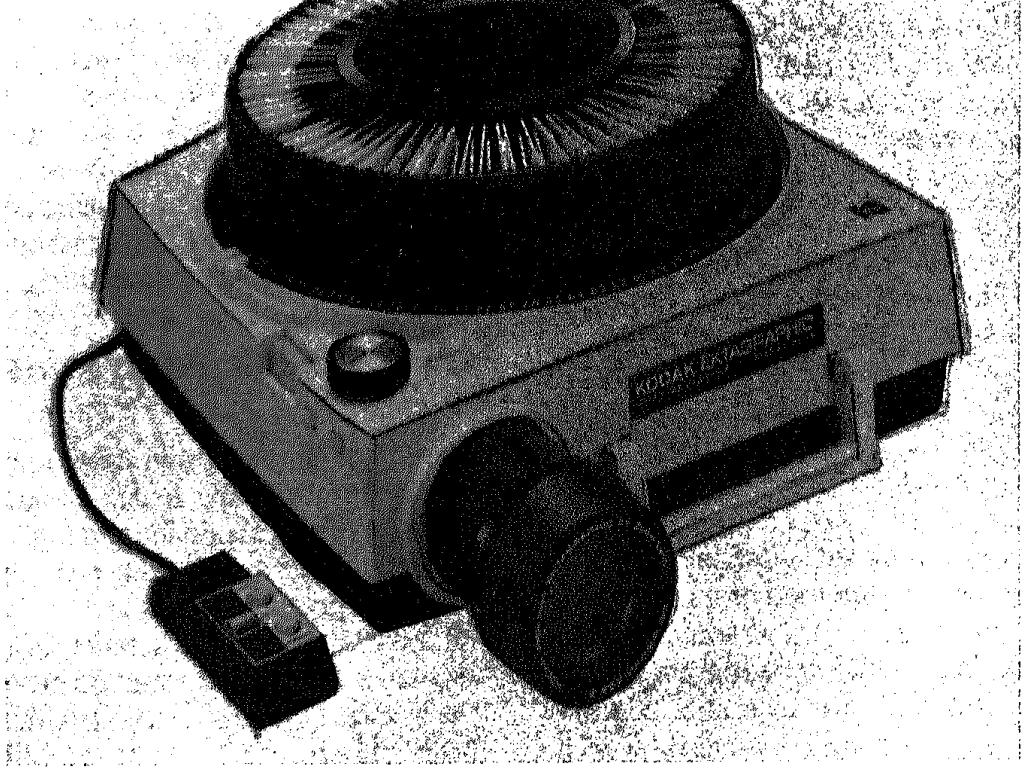
- Each print should be self-sufficient and self-explanatory.

- Prints should be of the highest quality.

- Prints should be displayed in a carefully planned and professionally executed manner, not haphazardly "thrown" on a wall or display board. Remember, an improperly displayed photograph loses impact and effectiveness regardless of how good it is.

## SLIDE SERIES

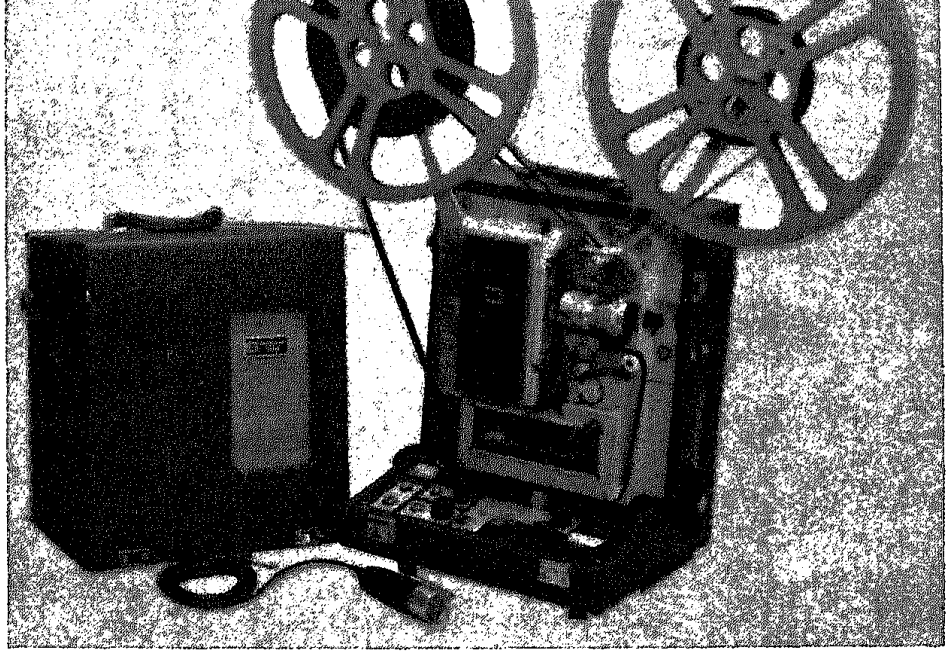
Slides have several strengths for communications, one of which is they can *hold an audience's attention.* Think of the times your undivided attention has been held by a series of strong and interesting slides. A properly designed slide series helps get a message across quickly, captures the audience's attention, and



builds interest. Slides help *clarify points* by showing realistically or in abstract what is being discussed. Through the time and space potential of slides, an audience and speaker can share experiences otherwise impossible or impractical. For example, many people shoot slides during their vacation, and upon returning home, show the slides to friends. Such a slide series, if done well, gives the viewers a vicarious vacation trip. Other advantages of slides are: they *focus attention* on a large screen image, and *they are flexible*, meaning that they can be added to, removed, or rearranged for different presentations.

## MOTION PICTURES

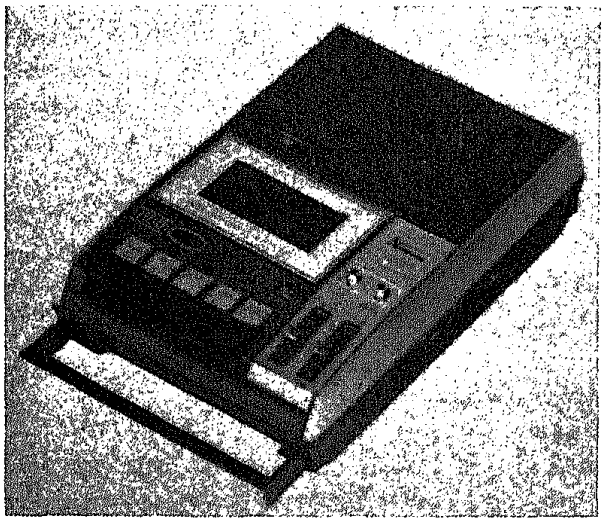
One of the most universally known visual media is motion pictures. Audiovisual pictorial materials, except videotape, are essentially adaptations of still pictures to make them conveniently visible and to facilitate a smooth sequence of presentation. Motion pictures, however, add the element of motion; not only the ability to depict motion as it appears to persons viewing the original movement firsthand, but also to slow down fast action and speed up activi that would otherwise be impractical to obse Still picture techniques can imply motion, br it down into its components, and freeze it convenient study. But when movement or a se of movements are important as in an integra operation, motion pictures can depict the seque completely and adequately. If you wanted depict the activity and dynamics of an airc launch from a carrier, what visual media wo best serve your purpose? In this hypothet situation you want to show the intense action t takes place prior to, during, and after the laun Still pictures would only imply action by freez the action or by using blurred images. Mot pictures would probably be the best medium this situation. Motion pictures can be one of most costly of the audiovisual materials and r require extensive equipment, skilled person and a relatively longer production time. Des this, for some purposes, nothing surpasses motion picture in effectiveness as a medium communications. Motion pictures should considered whenever motion is inherent in a gi subject or when you wish to build continuity action as in the aircraft launch. Motion pictu



also create a dramatic impact on a viewing audience. Movies need not always be formal lengthy productions; for some purposes a short film will be sufficient.

## AUDIO RECORDINGS

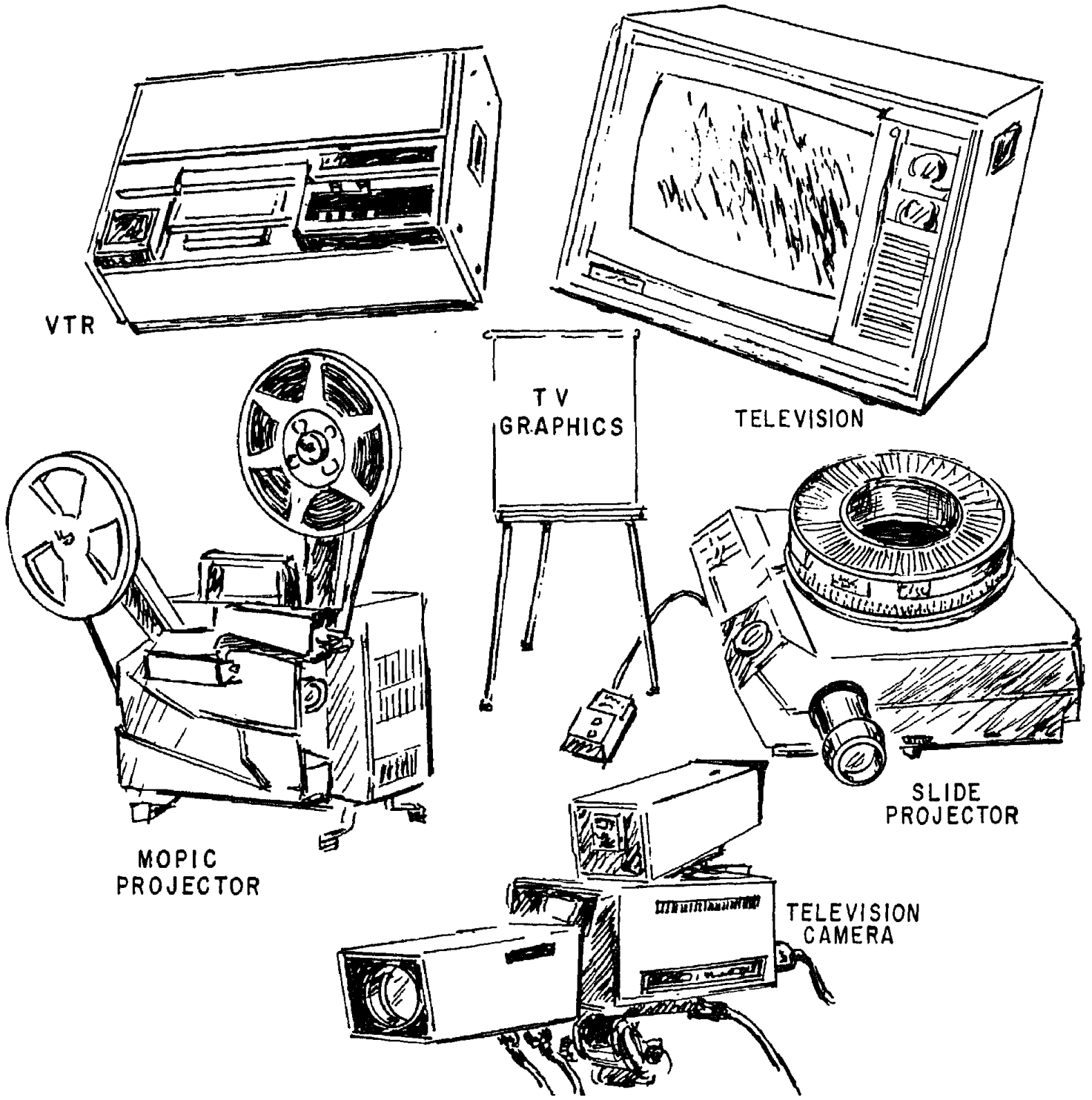
Audio recordings are a versatile AV medium because they can be used separately or in combination with other AV media for individual or group use. Tape recordings can serve alone as the audio direction to perform a task or a series of tasks such as the operation of a piece of equipment and/or they can be correlated with visual materials for effective audio and visual presentations.



## VIDEO RECORDINGS

The use of video recordings for television is rapidly growing in our modern Navy. Many ships now have closed-circuit television systems. An instructional, informational, or entertainment television program may, and usually does, employ a combination of visual materials such as graphics, photographs, slides, motion pictures, etc.

The success that TV has gained comes in part from the wise selection of the best aspects of all the other audiovisual materials and their proper use. Audiovisual materials for television are unlike other audiovisual materials because they are not ends of production but contributions to the total televised presentations. Their effectiveness must be assessed in terms of the support they give to the purpose of the entire presentation.




The choice of visuals for TV depends not only upon the purposes to be served by the materials, but also on the ways they will be displayed and used during the program. The method of use determines whether information should be presented; for example—as a slide for projection or as a large chart for use in front of the TV camera. Ease and speed of preparation, required skills, facilities, time, and material costs are other factors that influence your choice.

Finally, the technical requirements for television—format, proportions, size, color, and contrast limitations must all be considered as materials are selected and prepared.

## MULTI-IMAGE

If a single visual can do the job, avoid the temptation to try something different simply for the novelty of it. But when combinations of

visuals or visuals and audio are the most effective presentation methods, then they should be used—either simultaneously be or in succession.

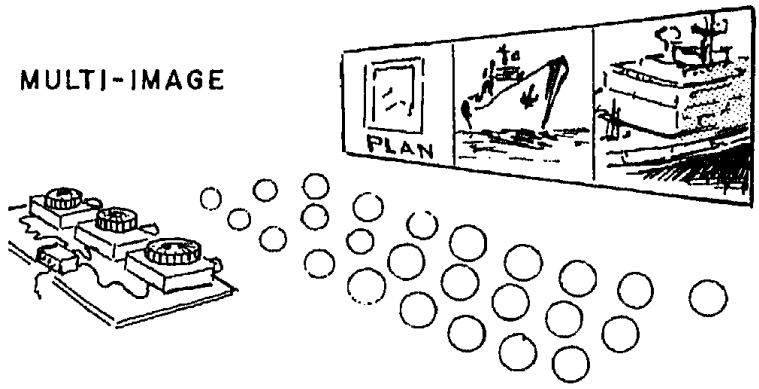
There is a difference between multi-image and multi-media. Or is there? Ask several authorities to define multi-image and multi-media and you will probably get as many definitions as there are authorities. However, for the purpose of *our* discussion *we* shall define them as:

- Multi-media—The coordinated use of more than one AV medium for the presentation of information. For example, a *single*-screen, *single*-projector slide show with tape recorded narration.

- Multi-image—The use of two or more pictures projected simultaneously or in succession onto adjacent screens or screen areas for group viewing. Usually the coordinated images of two or more slides with synchronized narration, music, and sound effects are used. Brief motion picture sequences may be shown along with the slides for special impact. Or a speaker may provide dialogue as the program progresses.

It might be stated that multi-image begins where the average multi-media presentation ends. Multi-image is like a motion picture in that it may use cuts, dissolves, fades, and special effects. It is unlike a motion picture in that its special effects are created during the presentation through the use of programmed electronic equipment rather than done beforehand in the laboratory. It is like a slide show in that it generally uses projected 2 × 2 slides. It is unlike the simple slide show in that it generally uses multiple slide projectors with multiple simultaneous images on the screen. The images may be a part of a larger whole or they may be individual images that make different statements about the primary topic. Multi-image presentations are capable of mixing all the AV presentation methods into a unified whole. It offers a level of viewer participation unsurpassed by any other AV means.

## SLIDE PRODUCTIONS




with and without accompanying narrative or sound.

A slide show, if done right, can be a valuable communications medium. Perhaps you have had to sit through a slide presentation that seemed to drag on and on, or worse, you may have been part of producing such a program—one loaded with statistical data and text slides that had so much information on them that they weren't legible. A properly designed, professional quality slide presentation gains and holds the audience's attention and creates and builds interest.

Slides can be combined with other AV media to enhance the presentation. For example, a slide show may be used for speaker support wherein the speaker uses slides to emphasize points he wants to make. In this case, the speaker provides the narration for the slides as the images appear on the screen. The speaker can hold a slide for a long time or quickly move from slide to slide and even go back to a specific slide during a question and answer session, etc.

When slides are used, selected areas of charts, graphs, maps, etc., can be photographed and enlarged so the audience's attention is focused on the particular area of interest.

Some of the approaches you have to put together a slide program include using:

- Existing or file slides.

- New photographic coverage of a situation or event.

- A script and storyboard to produce the required pictures.

- A combination of each of these approaches

## STEPS IN PLANNING AND PRODUCING A SLIDE SHOW (AN OVERVIEW)

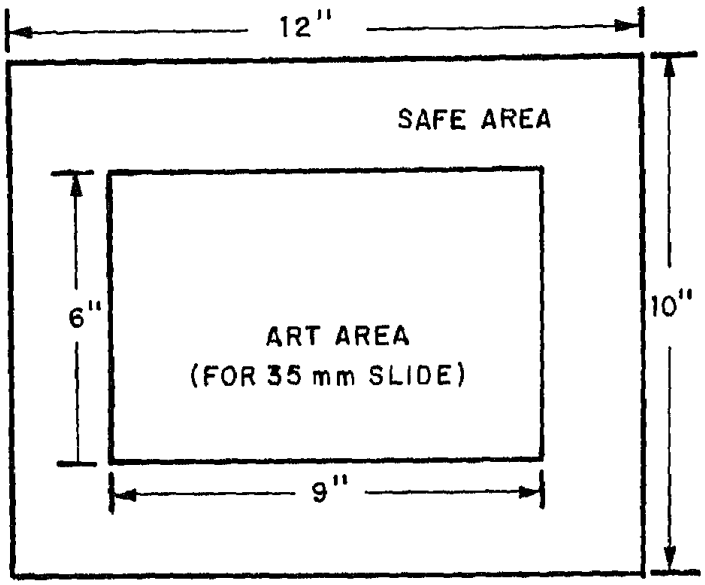
The following steps should be followed in producing any professional slide presentation.

1. Define the objectives.
2. Analyze your audience.
3. Make an outline.
4. Review your progress.
5. Write the story treatment.
6. Prepare the storyboard.
7. Write the script.
8. Plan the slides. Develop your visual ideas.

The outline, story treatment, storyboard, and your script will be your guide. As you plan your pictures, keep these rules of thumb in mind:

● *Use a horizontal format.* The standard 2:3 ratio of a 35mm slide in the horizontal format usually results in the most effective slides. Vertical slides don't work well in most single-screen, single-projector situations.

● *Prepare the artwork using a 2:3 ratio. (For 35mm slides.)* For example, do the artwork on a 10 × 12-inch horizontal format card using only the 2:3 ratio 6 × 9-inch art area.




● *Keep all copy simple and legible.* Don't use small type, thin lines, or poor color contrasts. Limit typing or lettering to not more than a maximum of 8 double-spaced lines and 43 elite or 36 pica characters to a line. Better yet, limit word slides to not more than 15 words.

Light-colored lettering, symbols, and art should be used against dark-colored backgrounds. Clear, white, or light-colored backgrounds show dirt and dust and create harsh distracting glare when projected.

● *Make all slides simple and bold.* Don't have more than one main idea in a text slide. Use several simple word slides rather than one complicated one.

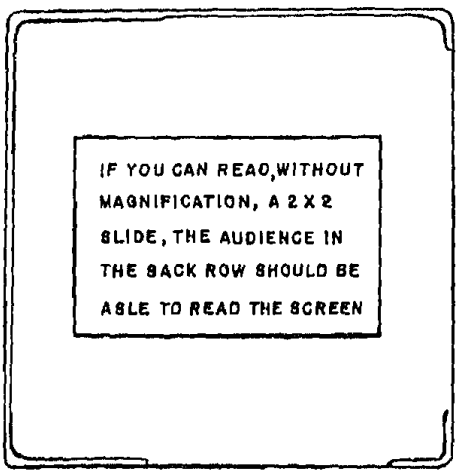
● *Use charts and graphs rather than word tables to present facts and figures.* Tables look complicated and confusing, whereas charts and graphs provide quick, easy visual comparisons.

● *Keep the photographs uncluttered.* Plan your shots carefully. A close-up showing details may be more effective than an overall view. Good lighting and composition are important.

● *Don't leave a slide on the screen too long or too short a time.* Pacing the program is important. The audience needs enough time to see, study, and read the slide at a comfortable rate, but don't rush or bore them. Remember the 3- to 5-second rule.

9. Make all slides legible. Throughout production, check each slide to be sure it is legible. All elements of a slide, text, or otherwise, must be sufficiently sharp and large enough to be seen and read by those people on the back row. Copying a chart or graph which is legible doesn't guarantee legibility in the slide. Slide legibility is affected by:

● The size, amount, style, and contrast of the slide—text or picture.



room.

- The projected image size.
- The viewer's distance from the screen.
- The amount of time the projected image is on the screen.

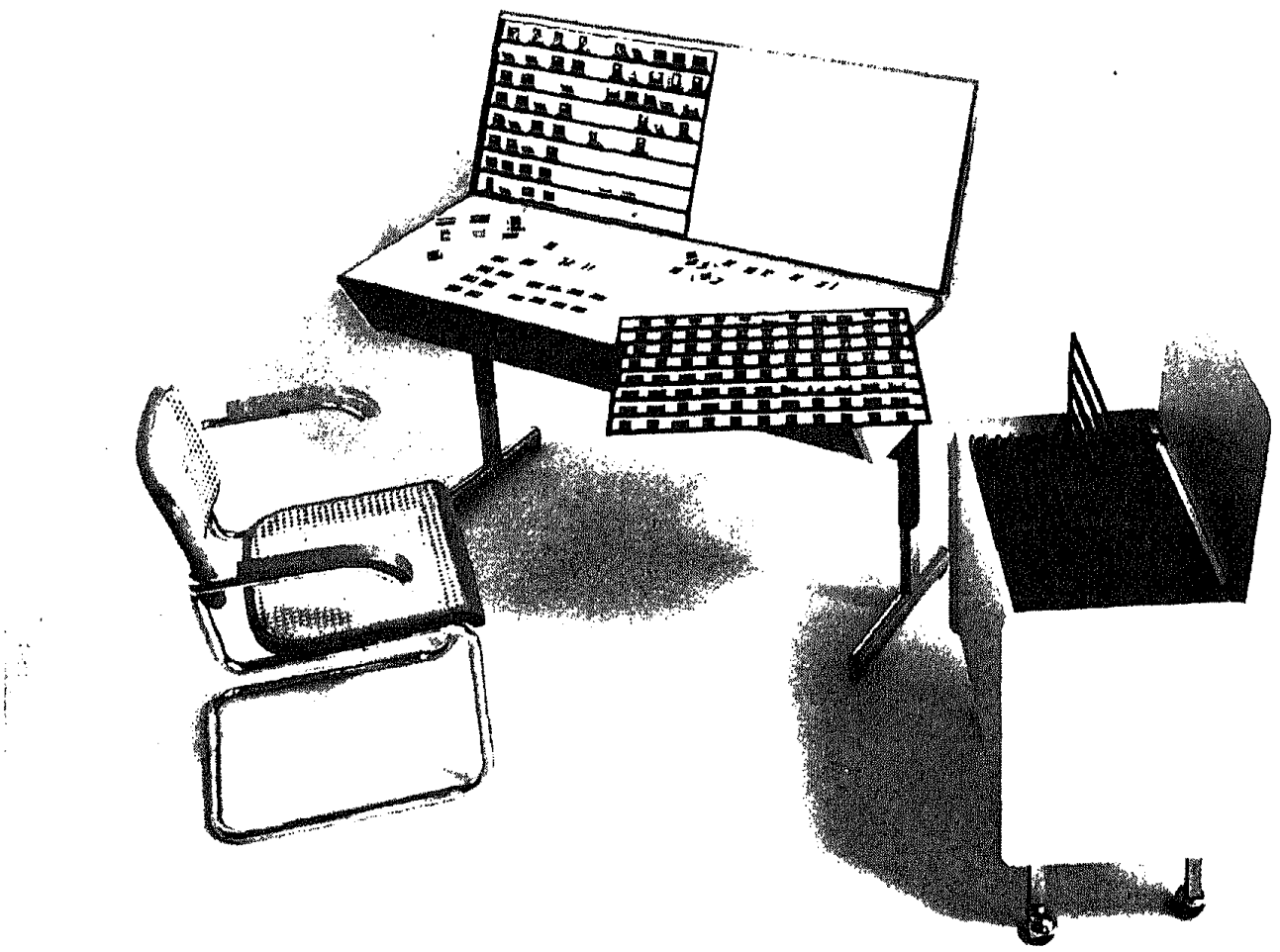
10. Edit the slides. Use the outline and script as a guide during this process. Check the slides against the script for sequencing and to be sure you have covered each point. During the editing process, answer each of these questions:

- Have all the points in the outline been covered?
- How well does each slide match the narration and/or sound effects?
- Is each slide legible?
- Are the colors in the slides bold and effective; do they contrast well?

how well does it present that idea?

- Does the presentation have good continuity?
- Does the presentation meet the objectives of the program as previously stated?

During shooting, the pictures may have been made out of script sequence, some scenes which were not included in the script may have been shot, and more than one shot may have been made of some subjects. During the scriptwriting process, the narration or sound effects may have been written in rough form only. Even if they were written "smooth" there will probably be a need for change. These changes and possible deviations from the script, among other factors, make it necessary for you to give careful examination, selection, and organization to all the slides and narration, if the show has sound. This is the editing process.



*Courtesy Matrix Division/Leedal, Inc.*

Place all the slides on slide-sequence illuminators for ease in viewing. Using the script as a guide, arrange ALL the slides in proper sequence. Examine the slides; throw out the ones that do not meet your high standards of quality until the remaining slides are limited to only those of highest quality that fit or *supplement* the script.

Now you must make choices from among the multiple takes of a scene. Examine all the slides that are left with a critical eye. Be impersonal in your judgment—eliminating those slides that do not make a suitable contribution to the specific objectives or purpose of the presentation. Be firm in rejecting slides that do not meet the required standards.

Now revise the script as necessary. If you have made changes in the original script by adding scenes or changing the sequence, rewrite the visual side of the script to fit the edited slides. If spoken or recorded commentary is to accompany the presentation, refine it to fit the edited visuals.

**Evaluate the Presentation**

With the editing finished or at least the preliminary editing finished, your slide presentation is nearing completion and it's time to "run" the show and evaluate it. At this point, you should show the presentation and the narrative to qualified persons for suggestions and comments which may help make the show more successful.

Some of the things to look for as you and your fellow workers evaluate the show are:

- Does the material satisfy the program objectives?
- Does the presentation have good continuity—flowing smoothly from one slide or idea to the next?
- How well does the narrative support the visual images and does it aid in continuity?
- Is the presentation too long; does it require deletions?
- Is the information and the quality of the presentation technically correct?

After evaluating the show, you may find it necessary to go back and do some more editing. You may even need to reshoot some of the slides or even shoot other scenes which were not included in the script. The point is, that each time you edit the presentation you should reevaluate it. Thus, edit, evaluate, edit, evaluate, etc., until it's right.

## AUDIO RECORDINGS

*Audio recordings can be used by themselves to convey information or they can be used in conjunction with visual materials.*

*If audio recordings used by themselves are nothing but oral duplications of reading matter or contain information that could just as easily be read, then, the recordings have little to offer in the way of a carefully designed AV presentation. However, most of the audio recordings you will make will be for use in conjunction with other AV media, such as slides, multi-image, motion pictures, etc. Therefore, while reading and studying this section, keep in mind that most of the information presented applies equally well to sound recordings for the other AV media.*

Planning an audio recording requires the same care as planning any other AV production. The following sequence should be followed in planning an audio recording:

1. Define the objectives.
2. Consider the audience.
3. Make the outline.
4. Write the treatment.
5. Write the audio script.

## PROBLEMS IN WRITING

slightly ashamed, if your critique of yourself is genuinely objective. The shortcomings which show up are either in the area of grammar or in the qualities or characteristics of your voice. The grammar problem is most likely the result of a problem or problems in your writing, especially the writing of a narrative script.

The first so-called "rules of English grammar" were established by scholars during the eighteenth century. These men considered that English should follow the same rules as the then very orderly and precise rules of Latin—the language of educated men. This system did not work well because English was and is a living, changing language, a fact which they failed to take into account.

An American scholar has said of English: "Its bookish times are its decadent times, its talking times, its glory." He meant that you should choose the informal rather than the stilted, the informative rather than the formal phrasing. This does not mean, of course, that "anything goes." For example, you can get into trouble and fail to communicate by using modifiers carelessly. You can put your audience to sleep by overusing the passive voice and indirect phrasing. These and similar problems in grammar are likely to be most deeply rooted in your written communication. From there, they quite easily carry over to your oral communication. In this section, we will study confused and improved examples of communication. We will look first at problems of written communication (scripts); then we will examine problems of spoken communication (recordings). In planning and producing audio recordings such knowledge is indispensable, whether the recordings are to be used alone or in combination with other AV media.

**Grammatical Problems**

Although there are many grammatical problems, some are especially troublesome. These include:

- The split infinitive.
- The use of modifiers.
- The use of indefinite reference words.
- The use of the active and the passive voice.
- Indirect phrasing.
- Pronoun agreement.
- Agreement in construction. It is not a grammatical problem—but related to such problems, especially when formal phrasing is involved.

SPLITTING THE INFINITIVE.—The formal grammarians have just about lost the battle of the split infinitive. The prevailing view is that it isn't necessary to deliberately split the infinitive but that you should split it if what you are saying sounds better by doing so or if it seems more natural, but, at the same time, it does not confuse your basic meaning. Consider the following sentence:

*The supervisor studied methods to better organize his office.*

The word "better" slips into an "adverb suit" and splits the infinitive "to organize." Where else should it go—more effectively, that is? The answer is, "nowhere." Before "to," "better" sounds awkward:

*The supervisor studied methods better to organize his office.*

And the meaning is changed when it is placed after "office."

*The supervisor studied methods to organize his office better.*

Solution: *Leave it alone.* It sounds better where it is:

*The supervisor studied methods to better organize his office.*

This phrasing puts the modifying adverb as close as possible to the verb it modifies.

PLACING MODIFIERS.—To the basic subject-verb and subject-verb-object sentence patterns we add words (modifiers) to elaborate, describe, or clarify. They may modify one of the three basic elements or all three together. You should keep each modifier close to the word it

modifies. Here are some types of errors caused by misplaced modifiers:

● Dangling modifier. When a word or phrase seems to modify another word which it cannot logically modify, we say it has been left *dangling*. Usually such a dangling phrase appears at the beginning of a sentence. From this position, we expect it to modify the basic sentence's subject. But suppose that the connection is illogical. In such a situation, the introductory phrase is left dangling. Compare the following examples:

Confusing: *Approaching the flight line from the east side, the operations building can be easily seen.* (The operations building does not approach the flight line.)

Improved: *A person approaching the flight line from the east side can easily see the operations building.*

● Misplaced modifier. Sometimes, by placing the modifier widely separated from the word it modifies, we end up inadvertently confusing our readers and listeners. For example, in the example below, just what does the prepositional phrase "in the dark" modify?

Confusing: *It was impossible to find the book that I had been reading in the dark.*

Improved: *In the dark, it was impossible to find the book I had been reading.*

● Squinting modifier. The modifier may also be placed so it would logically relate to either of two words. This—the so-called *squinting* modifier—may confuse readers and listeners. Yet they may not realize the ambiguity, and thus, misinterpret the intended meaning.

Confusing: "*Suwon is the place where the South Korean radio said early today the government had fled.*"

Improved: "*Early today the South Korean radio said the government had*

INDEFINITE REFERENCE WORDS.—We use words or pronouns such as "the latter," "the former," "this," "that," and "it" to refer to something we have previously mentioned. This reference must be perfectly clear to people. The following example illustrates the ambiguity which results from faulty placement of reference pronouns.

Confusing: *The captain told the electrician he would replace the light switch.* (Who is going to replace it?)

Improved: *The captain told the electrician to replace the light switch.*

ACTIVE AND PASSIVE VOICE.—When you arrange a sentence so that the subject receives rather than performs the action, you are using the *passive voice*. You should use this form *occasionally* for sentence variety. It allows you to emphasize the action rather than the doer. But don't overdo this. You probably do not normally use it purposely; but habitually. Besides, the *active voice* is both more forceful and more natural.

| | | | |
|---|---|---|---|
| Active: | *The pilot* | *flew* | *the aircraft.* |
| | ACTOR | ACTION | ACTED UPON |
| Passive: | *The aircraft* | *was flown* | *by the pilot.* |
| | ACTED UPON | ACTION | ACTOR |

As a matter of fact, "actor" is often dropped entirely, for example, "*The aircraft was flown.*" Let's look at some typical passive examples:

- *Requisitions will be submitted.*
- *The committee will be appointed by the commander.*
- *Reports have been received.*
- *Provisions will be made for . . .*

In most of these situations, we should be emphasizing the actor word rather than leaving it out or subordinating it. These sentences are more effective in the active voice.

- *Supply officers will submit . . .*

- *Provide for . . .*

Perhaps your worst offenses will occur when you write dialogue or scripts for instructional material. You should be directing your instructions to someone, or to some group, yet you may tend to write long complex sentences in the passive voice. This type of script takes very careful reading or listening to determine the intended meaning.

BE BRIEF, PRECISE, AND ACTIVE.

INDIRECT PHRASING.—Closely related to passive voice construction is *indirect phrasing*. Here are some examples:

- It is requested . . .
- It is recommended . . .
- It has been brought to the attention of . . .
- It is the opinion of . . .

Such examples as these are probably so familiar to you that you don't even question them. But *who* requested? *Who* recommended? *Who* believes? The indirect way of writing, by using the passive voice and indirect phrase, is perhaps the result of the writer being afraid to take responsibility for what he is writing. The writer might believe this style makes him anonymous or makes him sound less dogmatic and authoritarian. But "*Submit your requisitions . . .*" is no more authoritarian than "*It is requested that requisitions be submitted . . .*," and it is also more direct, clearer, and briefer.

PRONOUN AGREEMENT IN NUMBER.—Every pronoun you use should agree with its antecedent in number, person, and gender. Examine the pronouns in this incorrect sentence:

*If a person studies industriously, the benefits will come to them eventually.*

be corrected:

- *If a person studies industriously, the benefits will come to him eventually.*
- *People who study carefully will find that the benefits will come to them eventually.*

AGREEMENT IN CONSTRUCTION.—Errors like the preceding example (pronoun agreement) should also be avoided for logical, as well as grammatical, reasons. If you start out with a plural subject in mind, you should end up with the same plural subject. There are at least two other kinds of shifts in sentence construction that you should avoid for similar reasons. Study the following examples:

- Active to passive: *We took turns driving and fatigue was avoided.*

  Better: *We took turns driving and avoided fatigue.*

- Shift in grammar form: *A man who enjoys fresh air and to keep his health should not work indoors.*

  Better: *A man who enjoys fresh air and who wants to keep his health should not work indoors.*

**Brevity of Expression**

You should be able to understand the formal and somewhat legalistic language of many directives and regulations which will govern your conduct. You should also be able to understand scholarly treatment of technical features appropriate to your job. Both are inclined to be lengthy and complex. Just the same, you should avoid passing on such information verbatim to the AV audience. Relax your English accordingly. Here are some examples to help illustrate what we mean. They are written first in a somewhat formal manner, then in a suggested modification.

The principle difference between the two is brevity.

- Formal: *All division officers will warn their men to stay away from the seawall. It is not safe, and men may be hurt.*

- Modified: *Division officers, your men can be hurt at the seawall. They are not allowed there. Warn them to stay away.*

- Formal: *The Whiting Field Navy Exchange will be closed 15 and 16 Jan. in order that this store can be moved into its new location, Bldg. 5449. The exchange will open at its usual time on 17 Jan.*

- Modified: *The Whiting Field Navy Exchange will be closed 15 and 16 Jan. for moving to its new location, Bldg. 5449.*

## PROBLEMS IN SPEAKING

There is considerably more involved in holding the attention of a listening or viewing audience than in just being grammatically correct. A good voice is important; perhaps most important. Proper position at the mike, proper emphasis of words and phrases, skillful use of body movement and gestures (in a motion picture), and visual aids can also add to a performance. Knowledge of these things is fundamental for one who would write, announce, or direct AV productions.

### Voice Control

Much of the success of AV narrators can be attributed to voice "projection." Sometimes voice projection is natural, but more often it is acquired through practice. The deep, resonant voice does not always project well on TV and is not always adaptable to all AV programs. What, then, are the qualities and characteristics of a good AV voice?

- *Pitch.* Pitch changes are a part of normal speech. Your pitch range is the distance between the highest and lowest tones you can speak comfortably. Your normal pitch is the one you use most often. For most people, you should select a point about one-fourth up from the bottom of your natural range. Use this voice frequency as a midpoint, so that you can vary above and below it to provide expression. Be on guard against picking up a singsong habit. Pitch changes should be reserved for emphasis, suggesting excitement, or a query.

- *Quality.* This is principally a matter of tone, and you do the best you can with what you have. Your resonant chambers are from nature, and you cannot change them. Nevertheless, with instruction and practice, you can use them advantageously.

- *Volume.* Having enough volume is important. But remember, that volume is an excellent means of expressing a point. Volume trouble usually stems from poor posture, tension, or poor breath control. Standing straight will help; so will relaxing the throat muscles. Couple these suggestions with better breath control, and you will present a much more acceptable voice.

- *Breathing.* This is one of the more controllable features of speaking. We speak on the exhalation phase, which means that we must exhale a little more slowly than we inhale. This does not mean that you should gasp your lungs full before diving into the dialogue or at the end of phrases. This can generate tension and will be obvious to listeners and viewers. How deeply you inhale will depend on the length of the phrase to be voiced. Inhalation should take place during pauses and should approximate your normal breathing. Knowing your script is one way to aid breath control, volume control, and tone. A course in public speaking and much practice can help almost anyone to gain good voice control.

### The Delivery

Consider these next points as necessary for you to make the most of a good voice. These are *absolute* requirements if you are to get your message across to your listeners and viewers so that they will understand you, and perhaps just as important, want to listen to you again. As a narrator or speaker, you become successful

As a narrator, you should pronounce words the way the majority of educated people do. That means you must avoid or minimize the following difficulties.

● *Personal deficiencies.* Such deficiencies are many and varied, and some of them may not be altogether correctable. Look for those affecting you and practice to improve. To take one example, a high-ranking Government official recently gave up, before the cameras, on "phthisic." He explained that he had discovered his inability to pronounce it and had asked that it be deleted and a synonym substituted in the final script. It wasn't. Substitution of a synonym may not provide an escape for the AV announcer. Accept the challenge and practice. Also, practice words that have dissimilar consonants side by side which sometimes give trouble to lips and tongues with poor mobility. For example, one announcer consistently pronounces the word nuclear "new-cue-lar." It should be pronounced "new-clee-ur."

● *Geographic flavor.* Where you come from, it may be correct to say "bawth." Nevertheless, "bath" with a short "a" similar to "bat" is the choice of the majority. It is best to minimize the broad "a." Do you say prep-ratory? Better stick with "preppar-atory," at least until Britishisms are accepted more widely.

● *Occupational patterns.* The military seems to have introduced or to have been involved in introducing some of these variations for practical reasons. For example; when commands are given on the drill field, the normal sound of the word "oblique (ob-leek)" seems too weak to carry clearly for long distances. This is why it is pronounced "ob-like." The dictionary, which should be your guide in most matters of pronunciation, recognizes both. For practice you might look up "data," "depot," and "precedence," and compare them with what you hear around your organization.

● *Foreign words.* Notice, just above, that you were referred to the dictionary to settle most uncertainties of pronunciation. However, an ordinary English dictionary may not help you with names of foreign places that are smaller than a country, unless the place has acquired some geographical dictionary; it just may have the place name you need. If you find no help, do your best by "anglicizing"; i.e., render according to English idiom, usage, etc.

● *Personal names.* When a word causing you difficulty is a person's name, the problem is more difficult. It is courteous to use the pronunciation favored by the bearer of the name. If the person is available, ask him. If not, try to find some other local authority. If the person is famous, try the biographical section of a dictionary. There is usually a lengthy list of famous persons, including some who are still alive.

You must anticipate any other pronunciation trouble by checking the script in advance. You should also make every effort to check all available sources for correct pronunciation of doubtful words. Someone has said that you should treat every word as if you had a ten dollar bet riding on your ability to pronounce it correctly. If you really had such a stake in pronunciation, that most important tool—the dictionary on your desk—would probably have worn out long ago.

**Enunciation**

This is the art of saying words distinctly and clearly. Slurring or running of words and phrases together is usually the result of laziness. A loose denture or a too rapid speech rate can also be a cause. Faulty enunciation can be corrected through proper use of the tongue, teeth, and lips to pronounce the words properly and opening the mouth to let the words out. Instead of saying "Wheredjago?" say "Where-did-you-go?" If you talk too rapidly, some listeners will compalin that they can't follow, partly because of voice shortcuts causing speech slurring or dropping final letters of a word. If you talk too slowly, your audience may get restless.

RATE OF DELIVERY.—Other than cautioning you to avoid either of the two extremes, slurring or dragging, no standard speed of delivery can be prescribed. Your overall rate of delivery will be determined by the number of words in a given segment. This does not mean that you must adhere to a certain number of words per second throughout the narration. In fact,

dialogue meaning. This is the technique of speeding up for the unimportant phrases and slowing down for phrases which require emphasis. To prepare for this, practice reading the script or dialogue before recording.

## BODY MOVEMENTS AND GESTURES

The use of the body is more important in TV and motion pictures than it is in recording just sound or sound for a slide presentation, etc. However, if all your muscles, except the vocal ones are held motionless, it may be more difficult for you to create the proper mood for your narration. It is natural for most people to use hand motions and facial expressions while talking. They point their fingers, clench their fists, and smile or frown. If these activities fit and enhance the words and mood of your presentation, go ahead and use them. However, beware of movements that create a sound which the audience may not understand. For example, pounding the desk before a TV audience might be effective, but not for a slide show where the narrator won't be seen.

## MUSIC AND SOUND EFFECTS

Although background music is not always essential for effective AV communications, and in some cases may actually degrade communications, it may help by creating a desirable mood to maintain continuity. Background music for titles gives the projectionist a chance to set the volume level for the sound that follows. When music is used with narration, it must be at a volume low enough that it does not interfere with the narration or detract from the visuals and compete for the audience's attention.

The type of background music you select should have an even tempo and be descriptive of your program. By descriptive, we mean, for example, that you wouldn't select the theme from "A Summer Place" as background music for a multi-image production about USS *New Jersey* shelling North Vietnam. A better choice may be "The William Tell Overture." Semiclassical music is usually more appropriate than popular or classical music. Semiclassical selections usually use copyrighted music in your productions. There are a number of commercial music libraries that, for a fee, can provide all kinds of music and sound effect recordings.

Sound effects can be included with your AV presentations to add a sense of realism. You can record the real sounds or create your own sound effects.

Although in the final AV presentation your audio material may be used with a cassette tape player, it is best to make the initial recording on 1/4-inch tape with a reel-to-reel recorder. The sound quality obtained with 1/4-inch tape is better than cassette recordings and 1/4-inch tape is easier to edit. Once the tape is edited, it can be copied (duped) into cassettes. If only narration (voice) or sound effects are being recorded, a tape speed of 7 1/2 inches per second (ips) should be used. Music, however, requires higher fidelity than voice and, therefore, should be recorded at a tape speed of 15 ips.

There are many kinds of magnetic recording tapes on the market. The tape you choose to use depends mostly on how you plan to use the recording. Your best guideline is recording time per reel at your chosen tape speed.

For relatively short recordings, 1 1/2-mil tape offers advantages of low cost, low print-through (signal transfer from tape layer to layer), and long life. 1 1/2-mil tape provides high-quality recordings.

For longer recordings, 1-mil tape may be required. 1-mil tape provides 50 percent more recording time (at a given ips) than 1 1/2-mil tape on the same size reel.

The longest available recording/playing time is obtained with 1/2-mil tape. However, this very thin tape can't be used with some recorders.

The best sound recordings are produced in acoustically soundproof rooms. Ideally, the recording room or facility should have drapes on the walls and be carpeted. However, the room should not be "deadened" entirely. A room which has been completely deadened makes narration sound dead instead of vibrantly alive. When a sound recording studio is not available, you can improvise by using a corner of a room with some drapes or blankets to reduce sound reflections. Then record after normal working hours to eliminate excessive noises.

When you choose a room to use for sound recording, remember that the microphone can't distinguish between the sound from the narration and ambient noise such as air conditioners or sounds coming from outside the room, etc. An annoying background hum caused by 60-cycle interference may be picked up by the microphone and recorded—especially in proximity to fluorescent lights or high voltage power lines (usually 220 volts).

## AUDIOTAPE EDITING

After making the tape recording, you can edit the audiotapes to remove undesirable segments, change wording, delete unwanted background noises, rearrange segments, and combine selections. Tape editing is a process that requires skill to handle the alterations to be made. With tape editing, it is possible for you to:

- Reduce the overall length of the recording.
- Rearrange the order of events by changing the sequence of narration, etc., thus providing a basis for emphasis, contrast, and comparison.
- Insert speech, music, and sound effects.
- Add pause-cue signals to control synchronized sound-visual presentations.

Most tape modifications or editing can be done electronically; i.e., by playing the original recording into another recorder and onto new tape without cutting the original tape. With this method, the portions of the original tape which are to be edited out are not rerecorded while inserts, pauses, cues, sound effects, new

Another alternative, but less desirable, is mechanical editing of reel-to-reel tape; i.e., cutting and splicing the tape with scissors or a tape splicer.

Splicing is only practical when one track is recorded on the tape. If you splice multitrack tape it is very likely you will remove desirable sections of some tracks. When you record a narration, record only one track, then you can delete or rearrange the narration. It is good practice to splice a leader on each end of your tape. Leaders provide protection and offer full use of the tape.

Before you begin any tape editing you should make a high-quality duplicate of the original tape and store the original away. This will be your "insurance" in case you make an incorrect cut or record over while editing.

If the original recording was made on a cassette, it is best to make a working dupe on an open reel of tape. For successful mechanical tape editing, follow these steps:

1. Play the dupe of the original tape, listing spots to be edited. Use the index counter or the recorder to identify locations on the tape.
2. Replay the tape, stopping at each spot to be edited.
3. Locate the exact spot to be edited by moving the tape manually back and forth across the playback head.
4. Mark the cutting points on the base side of the tape with a fine felt tip pen.
5. Cut out the desired segment of tape and remove the felt pen marks; then splice the ends together or add the inserts, etc.
6. Repeat the procedure until the entire tape is edited.

### Tape Splicing

Although tape cutting and splicing can be done with a pair of scissors and some transparent tape, it is best done with a tape-splicing block. A tape-splicing block is a piece of metal that holds the tape in alignment while you cut at a 45-degree angle with a single-edged razor blade. There are slots cut in the block to guide the razor blade. The 45-degree cut, when taped, makes a strong splice that provides sound overlap between the two spliced pieces as they pass over the recorder's playback head. Always use a sharp blade to make straight clean cuts. Follow those procedures given

in the operator's instructions for the splicing block you are using.

If you don't have a splicing block, use scissors and follow this procedure:

1. Line up the tape ends, base side up and overlapping, cut through both tapes at a 45-degree angle.

2. Butt the two cut ends together without overlapping.

3. Cover the butt with splicing tape and rub firmly with your fingernail or an orange stick.

4. With scissors, trim away excess splicing tape.

5. Check the splice for strength and smoothness.

### Care of Audiotapes

Modern recording tape is tough and strong; it can be replayed many times without loss of quality or fidelity. However, the tapes can be damaged if mishandled. The following hints will help you get maximum trouble-free life from your audiotapes:

- Store tapes in their original containers to avoid dust, damage, and possible misidentification of the tapes.

- Avoid stacking tape containers. Store them on edge.

- Avoid excess humidity and extremes in temperature.

- Play tapes at room temperature.

- Keep tapes away from strong magnetic fields, such as those generated by some motors. This field, if strong enough, can erase recorded signals.

- If tapes have been in storage for 6 months or longer, carefully rewind them before using.

- Keep recorder heads, tape guides, and the capstan clean.

## SINGLE PROJECTOR SYNCHRONIZED SLIDE/TAPE PRESENTATIONS

In a synchronized slide/tape presentation, the slides change on cue with the accompanying recorded sound. The sound, usually in the form of a tape recording, can consist of narration, music and/or sound effects, and may also include slide change cues.

All synchronized slide/tape programs are generally shown with a projector which has a remote-control feature. This is because the socket on such a projector is used to connect the projector directly to the tape player or to a programmer or synchronizer for automatic slide changes.

The simplest way to make a synchronized slide/tape presentation is to record audible cues on the same track of the tape with the narration or music, etc. Then each time the projectionist hears the audible cue he manually changes the slide. A click-sound cue can be made when recording the sound with a microphone by tapping a pencil on a wooden surface each time a cue is needed. Or better yet, use a musical tone for the cues. An electronic tone generator such as those on some pocket calculators or electronic games can be used. With either type of cue sound, you will need to experiment to find the best distance from the microphone.

A slide/tape presentation with audible cues has obvious disadvantages. A projectionist is required and must pay careful attention to the cues to keep the presentation in synchronization. Audible cues are also likely to disturb and distract the audience. It is much better to use *inaudible* cues on the tape to automatically make slide changes.

Aside from the professionalism of a synchronized slide/tape show which uses inaudible cues, there are other advantages. The person putting on the presentation isn't preoccupied with manually changing slides. The show can be put on by someone who isn't acquainted with the content of the show. And the program can be repeated over and over without variation—each time the slides will change in the proper order and on cue.

## RECORDING THE SOUND

Once you have arranged your slides in the proper sequence, the sound track can then be recorded before recording slide change cues so that you can give your full attention to sound quality and pacing. At this stage in the production of a synchronized slide/tape program, slide changes will have to be made manually. The slide changes should be made by someone other than the narrator or the person operating the recorder or other sound effects or music equipment. If the sound recording is being made through a microphone, the projector must be operated and located so that its sounds are not picked up by the microphone.

The recording volume and the way narration and music or sound effects are "mixed" or combined will depend on the requirements of your equipment. When two separate tracks are available for recording, the sound—voice or narration, should be recorded on one track and music and/or sound effects on the other. This allows separate playback volume control of each track. By using the two-track technique, you also gain an advantage of being able to change either track at a later time without having to rerecord the entire sound accompaniment. When only two tracks are used for sound and slide change cueing, the sound is generally recorded on the left channel track and cues on the right channel track.

Using the script, record the sound and have someone manually change the slides at the appropriate time. Mark the script with a C to indicate a slide change.

## RECORDING SLIDE CHANGE CUES

Once you have recorded the narration, music, and/or sound effects, locating the slide change cues on the tape is simple. If the recorder does not have a built-in cueing device, a programmer or cueing device will have to be connected to the appropriate input channel, and the sound track output connected to a speaker. Play the tape and, following the script, place the slide change cues. Each time a cue point is reached, press the recorder's or programmer's cue or tone button. With most equipment you will hear the tone as it is recorded (a good reason for not recording sound and cues simultaneously), however, it won't be audible during playback.

### The First Cue

Placing the first slide change cue in the proper place on the tape is important. A synchronized slide/tape presentation generally begins with the screen dark and the title slide or first visual appearing simultaneously with the beginning of the sound or a "moment" later. With fully automatic operation, there are two ways to attain a dark-screen opening. The first is to use a projector which has an internal shutter that blocks the light when no slide is in the projection gate. The second method is to start with a "black slide" in the projection gate. A black slide can be a piece of opaque material (heat-resistant) in a regular slide mount. The projector lamp is turned on ahead of time and the black slide blocks the light from the screen.

With either method, the first cue will advance the projector, changing from the black slide to the first visual. This takes time, therefore, the cue has to be placed a little ahead of the sound start position on the tape in order to have the first image projected to the screen as the sound begins. You will have to experiment with the equipment to find where this first cue is to be placed on the tape. If you are using an open reel-to-reel recorder, you can use a felt tip pen to make a temporary mark on the *base* side of the tape so it can be reset to the same spot for repeated tests.

### Slide Change Timing

Since the purpose of a synchronized slide/tape presentation is to have the slides change at specific points along the sound track, timing is very important. Proper timing helps keep the presentation lively and keeps the sound and visuals in synchronization. The best time for a slide change may be right in the middle of a sentence—not always at the beginning or end. Slide change cues must be placed so each slide change takes place on the right words in the narration or with the music or sound effects. The narration should enhance, explain, or comment on what the audience is seeing. It should not describe what is obvious. The tempo or pace of slide changes must match the flow of sound information or the mood of the music, etc. If there are too many words for one visual, the audience's attention may be lost as soon as the visual content of the slide is understood. When there is lengthy narration, several visuals of the subject, properly cued, can

On the other hand, visuals that change in rapid succession should not contain much information.

The final timing of sequence of slide changes can only be arrived at by rehearsals in which experimental slide changes are made manually at one point then another until the best spot for each change has been found.

A good rule of thumb for timing slide changes is that the time a visual should remain on the screen is about 5 seconds. If the visual has to be on the screen for 15 to 30 seconds or more in order to have its contents understood or examined, it contains too much information and won't be very effective.

In a single-projector presentation, the time it takes for one visual to be removed from the screen until the next visual is on the screen, and the projector mechanism is ready to make another change is about 2 seconds. While this cycle time may vary from one type of projector to another, it's a good idea to allow a full 3-seconds cycle time. This limits how closely single-projector slide change cues can be placed on the tape. For a smooth flow of visual change, the accompanying sound should bridge the change with words, music, or sound effects. However, no *major* point of narration should be made during a visual change.

### Checking the Presentation

After you have recorded all the slide change cues, rewind the tape and run the presentation, from start to finish, in the automatic mode. Check to see that every slide change takes place when it is supposed to—at exactly the right moment. Don't stop the tape to make corrections. Instead, make notes as to when and where corrections need to be made.

After you have listed all the cue changes you want to make, go back and make them in order—from beginning to end. It is usually much easier to recue a complete section of the tape rather than only one or two closely spaced cues. If several cues need to be changed at different locations on the tape, it will probably be quicker and easier to recue the entire program.

When the entire presentation meets your satisfaction and is right, label the tape and add a leader marking it with the presentation title and can be placed at the beginning of the sound track to serve as a cue-up mark.

Cassettes should be labeled "This Side Up" or "Play This Side" for one-way tapes. For two-way cassette tapes, mark "Side One" and "Side Two" or "Play This Side First." And, finally, if it is a cassette tape, remove the tabs at the back of the cassette; this makes it impossible to accidently erase or record over the tape contents. The slides should also be locked into their trays and the trays labeled.

Since synchronized slide/tape programs are usually shown many times, the slides are often mounted in plastic mounts. Plastic mounts hold the slides flat in the projector gate. These mounts also lessen the danger of slide hangup, a possible hazard with gravity-feed projectors when cardboard mounts are used.

A single projector presentation can, of course, consist of more than one slide tray if time is allowed for changing the trays. A black slide or a title slide in the projector gate, or the "0" shot of a slide tray, allows changing trays without turning off the projector or interrupting the show.

## MOTION PICTURE PRODUCTIONS

In the days of the "Hollywood Spectacular," motion picture studio technical crews often exceeded 100 members. In turn, these were supported by a like number of "out-of-studio" specialists in the scenario, wardrobe, special effects, makeup, music, scenic, sound, laboratory, and a dozen more departments and organizations. Then the ratio of "off-camera" to "on-camera" people might easily reach 50 or 75 to 1.

In a typical Navy motion picture production a crew of this size might be "unusual," but not at all "unheard of." At the other extreme, there is the individual motion picture cameraman undertaking an assignment alone. This, too, is not the most typical pattern, but it is also not unique. The fact is, that even the single filmmaker, operating alone, is actually not alone in accomplishing the final production. At least several other people will be involved with the film before it is a final product. Therefore, the product will reflect the combined efforts of many people. Each person must depend upon someone else to make a contribution to the final accomplishment. Conversely, any individual at any point in the

production chain can cancel out the work of all the others and can destroy the end result if he fails in his responsibility.

## THE FILM TEAM

Motion picture production is no place for a "grandstander." Despite all the romance and glamour that has been associated with film-making, production is a total team effort. It is fine for "in-front-of-the-camera" people to think of themselves as stars, but it will not work on the other side of the camera. There is no individual member of a film production crew who can function without the cooperation and assistance of all the others—and they cannot perform without him. Awareness of this relationship is the beginning of an effective crew. Without it, motion picture production is not possible, regardless of whether 2 or 200 people are involved.

Because of the complexities in motion picture storytelling, it generally takes more than one person to make a production. This is especially true when you are filming controlled action. The size of your crew, however, depends on the kind of picture you are making. The *nucleus* of a full-scale crew usually consists of a director, a first cameraman, an assistant cameraman, and a crew chief. If the lighting requirement is large enough to warrant additional electrical power, you add an electrician to your crew. Including sound in your film necessitates expanding to a full-scale production crew. To your nucleus of four, you now add a second cameraman, a sound mixer, a recorder, and a mikeman for sound reproduction. Possibly more electricians are necessary. If so, you'll need a gaffer (chief electrician) to take charge of the electrical crew. In a big production there are so many props that you'll need a propman. Sometimes the prop personnel also take care of makeup; if they do not, you'll need a makeup specialist. Makeup is very important for CUs, where facial detail recorded on the film is highly magnified on the screen.

Finally, since you are using so much camera gear you need a grip (equipment handler) to take care of it. The grip's duties include moving your camera gear as required and helping you and your camera crew in general. By now you have noticed that as the production becomes bigger, the crew and the complications also become greater and more teamwork becomes necessary. You see how many as 12 or 18 persons. However, a Navy motion picture production crew usually consists of 4 or 5, especially when shooting on location.

> Much has been written about the psychology of the group and how it affects teamwork. But the best thing for you to remember is that good teamwork depends on the application of common sense and on the experience gained by your group members working together. If each man on your team knows his job and if he identifies himself with the group, working together as a team inevitably develops a better team. When we say that you must identify yourself with the group, we mean that you must, in terms of the group, subordinate yourself, your desires, and your wishes in order to weld the group into a smooth-functioning mechanism. If you study a particularly smooth-functioning motion picture crew, you will probably find the team has obvious *esprit de corps.* This is a well-balanced team that can be depended upon. The group has a good attitude; it is dedicated, efficient, and enthusiastic. It has initiative and a motive. Finally, it is a responsible and responsive team. If you are a member of such a team, you will probably develop the same characteristics—all of which contribute to improve the overall teamwork attitude. *Teamwork is contagious*—we can "catch" it from each other. Expose yourself to it—it is a good feeling to *belong* to a team.

### The Camera Crew

The camera crew is generally headed by a PH who is called either director of photography or first cameraman. The director of photography is in charge of the photographic coverage and the camera work to be done on a film. He and his staff are responsible for the quality of the finished image as it appears on the screen. The screenplay is best told through mutual understanding and cooperation between the film's director and the director of

director of photography strives to create realism in his work. Often, he suggests changes of action and position to improve photographic balance and composition as he sees it through his viewfinder. Today, with modern cameras and fine lenses, deeper perspective and broader vision are possible, images are clearly defined, depth and atmosphere are achieved, and line and composition as well as sharp dramatic angles are easily brought into "focus" on the screen. The cinematographer knows this; so his creative technique and technical knowledge must be exceptional and effective.

The director of photography is also concerned with lighting the set. It takes a combination of camera operation coupled with good set lighting to capture the mood of a scene. The director of photography generally has the final say as to which lighting setups are to be used.

Rarely does the director of photography act as the camera operator. His time is devoted to composition, lighting, and the smooth flow of the action from one scene to another. The director of photography indicates where the camera is to be placed on the set to best record the effects desired by the director. The director of photography also designates the appropriate lens to use, and strives for fluidity of movement to capture significant details and moods with clarity.

OPERATING CAMERAMAN.—The operating cameraman assists the cameraman or the director of photography, and is responsible for readiness and availability of all camera equipment that is used to cover the scheduled shooting. Under his direction, the equipment and accessories required for each setup are placed on the set. The technical aspects of making a film also come under his jurisdiction. In other words, the operating cameraman is responsible for the camera operation and for the sharp focus of every shot. The overall efficient operation of the equipment during the filming of each scene is his responsibility. He starts and stops the camera as directed, changes the lenses, and loads and changes magazines. He makes a record of each scene, and describes the subject matter on his caption sheet. He keeps his captions complete and up to date.

In formal studio productions, the director serves as the supervisor of the entire performing and technical staff assigned to the project. In typical controlled action productions, the director occupies a unique position within the crew. He does not perform functional tasks such as operating equipment, editing, or appearing as on-camera talent. However, in typical field filming, a separate director may not be included in the production crew. Yet, orderly coordination of production functions demands that some individual assume the responsibility and authority to determine and prescribe the course of action to be followed by the other crew members—someone must be in charge.

As a senior member of a Navy motion picture production crew, you may at times be the director. You frequently have to show your actors just what you want them to do. You may also direct the placement of lights and the microphones to be sure they don't cast shadows onto the set. As a director you may even be consulted on the amount and kind of editing needed. In short, you have to work with people.

To function as a motion picture director, you must develop an attitude of modesty, tolerance, and sympathy toward the problems of others. You may have to tell an actor what to do in a particular scene, and take whatever time is necessary to explain the situation. Most people associated with a motion picture are willing to cooperate if they know what you expect of them. Give them a chance to incorporate some of their own ideas. Don't fail to listen. These people may have some very good ideas, even though they are not camera specialists. We do not mean to imply that you must explain each and every action, but, you should keep your people informed to the extent that they know what is going on.

If you sincerely try to develop the following behavior patterns and attitudes, your job should be easier and much more effective.

- *Friendliness*—Know your associates on the team, and win their confidence.

- *Interest in other people*—Cultivate an interest in people and try to understand their individual differences.

easily sensed by the people you work with.

- *Pride in accomplishment*—Take pride in accomplishing a good job. Accept nothing less.

- *Patience*—Be patient. In the course of filming a picture, many things happen that tend to be discouraging. Patience is that characteristic which enables you to remain calm and to keep trying, even under adverse conditions.

- *Enthusiasm*—Like many other human characteristics, this one is contagious. Enthusiasm is exhibited in the vigorous spirit with which you attack a problem. It is evident in one form or another whenever a person is doing something he really likes to do. Enthusiasm is displayed in the way you do your job, rather than by what you say.

- *Fairness*—Being fair and unbiased with your fellow workers generally results in a better total product. Fairness will win for you the respect of your fellow workers and the respect of your supervisors.

MOTION PICTURE DIRECTING.—Directing is defined as "pointing out, prescribing, determining, initiating, or implementing a course of action." It is almost impossible to tell you how to direct your actors. However, if we discuss a hypothetical situation, you can get some guidance from it. Let's assume that you are responsible for the production of a film showing the diagnosis and treatment of psychological problems of pilots. In one scene, the patient, a pilot, approaches the psychiatrist's office door, hesitates for a moment, and then enters uncertainly. Inside the office, the doctor looks up from his desk, smiles, and rises to greet the pilot. The pilot approaches the desk and speaks to the doctor. The doctor answers and gestures toward a chair, indicating the pilot be seated. The interview commences. After it progresses for the usual time, the doctor makes his decision. He writes out an order committing the patient to the hospital and he also summons a nurse. The nurse takes the patient away.

After you decide what equipment you need, you call a meeting of the technicians and actors on the set. You give each person a copy of the script and ask them to read it. You all discuss the story until everyone knows it well. You consult with the lighting technician about the placement inside the office. Next, you talk with the sound technician concerning the placement of his mikes. Now you ask your actors to walk through their parts so that you can determine the camera positions and angles. If your actors are experienced, they will most likely play their parts realistically. They should need only occasional verbal direction from you. It may be necessary, once in a while, for you to take an actor's place and demonstrate the action you want. Even though you may not be an accomplished actor, you can get your ideas across to your people. Finally after the actors have learned their parts, you are ready to start shooting. The main thing is to undertake your job with *seriousness* and *earnestness*. Proficiency will come with practice.

In module 2 of this rate training series, we discussed procedures and techniques for filming uncontrolled, semicontrolled, and controlled action. This information was presented on an individual topic basis, as each related matter was covered. At this point, it is well to consider all these procedures and techniques together in a consolidated description of the motion picture production crew's duties.

There are certain well-established procedures and techniques used in motion picture film production. These procedures and techniques involve:

Story completeness

Continuity

Establishing scenes

Sequencing

Overlapping action

Cutaways and cut-ins

Composition

Camera angles

Panning

Captions and slates

The cover story

In speaking or writing about a condition, situation, or event, our objective is to describe

impressions and conclusions in such a way that our listeners or readers will understand, react to, and share our own interpretations and feelings. In effect, we are attempting to communicate a personal experience to others and inviting them to participate in it, even though they were not originally involved.

In visual communications, we go a step further by attempting to artificially create or reproduce a personal experience in such persuasive terms that others will have the impression they actually participated in it, even though they were not originally involved. Therefore, the effectiveness of any visual message is measured by the degree of personal involvement it arouses in the viewer.

In other media, effective communication can be achieved on an impersonal, intellectual basis, through the logical presentation of significant facts as perceived from the standpoint of the speaker or the author. However, to be effective, visual communications must convey a sense of personal participation in identifying the significant facts from the *standpoint of the viewer.* Therefore, any visual message must be presented in the viewer's terms, not in the narrative terms of the transmitter of the message.

The fundamental function of a motion picture director is to translate and/or interpret a visual message on behalf of the viewer and to convert abstract information into personal visual terms for his audience. We have noted that the camera operator *sees* on behalf of the viewer. The director *thinks* on behalf of the viewer. He must constantly place himself in the position of his audience and ask himself the question: "What visual information must I now have to understand what is being communicated to me?" His answers dictate his directional actions and decisions.

Audience Placement.—A major factor of directional decision concerns audience placement—what is the imaginary physical location of the viewer in relation to the source of the visual information that he perceives? Since the audience will only see what the camera "sees," the placement of the camera in relation to the action being filmed creates the illusion in the viewer's mind that he is physically on the same spot that the camera actually occupies. If the our visual purpose. The viewer can be moved directly into the action as a participant, or observe it from above, below, or from any side. His reaction to this mobility can be used to influence his personal interpretation of the significance of what he sees. This imaginary location of the audience results in the three basic modes of visual presentation: *objective*, *subjective*, and *point of view* (POV).

The objective audience placement mode positions the viewer so that he can function as an invisible observer. He sees the action taking place as would a spectator from the sidelines. Perhaps, he may even move about on the sidelines to look at the action from several different viewpoints, but he does not sense that he is personally participating in whatever is happening. He does not feel a direct involvement with the people in the action. It is imperative that none of the people in the action look directly into the camera lens, since this would establish eye contact with the viewer and totally destroy the illusion of objectivity. If this should happen accidentally, the scene must be reshot, because even one fleeting instance of an eye-to-eye relationship between the audience and an in-scene person has the effect of positioning the viewer some place within the scope of the action, thus making him a part of what is happening. Psychologically, it is impossible for the audience to remain objective if it senses that it is also a participant.

The subjective audience placement mode places the viewer into the action and makes him a part of it. He perceives the action as a participant and is personally involved in whatever is happening. Subjective audience placement may be achieved in several ways. For example:

- When the camera is used to represent the personal vision of the viewer, "seeing" what he would actually see in a real-life situation; e.g., placing the audience in the pilot's seat of an aircraft to "see" an approach and landing as the pilot would see it.

- When the camera is used to represent an exchange of position with an established in-scene person; e.g., if a performer is shown looking at something

relationship with an in-scene person; e.g., as in the typical eye-to-eye newscast in which the performer looks directly into the camera lens, creating the illusion that he is personally speaking to the viewer on a person-to-person basis.

In semicontrolled and uncontrolled productions, subjective audience placement is normally used only as an introductory or closing segment inserted into a basically objective presentation. In documentary-type films, the subjective audience placement technique has become quite popular and is often extremely effective. In this type of filming, the camera is used to represent the personal vision of the viewer, "seeing" the locations and events as if he were actually at the camera's position.

When preparing eye contact presentations including more than one person, as in the case of a reporter interviewing one or more eyewitnesses, you must make a basic directional decision. This concerns whether to proceed from an objective or a subjective basis within the interview. If a subjective treatment is to be used, the reporter will address the camera in his introduction, and the interviewee will also address the camera in his remarks. If seen together in a single shot, both will address the camera, not each other. Conversely, if an objective treatment is decided upon, the introduction may be addressed to the camera, but the interview must be conducted with the performers looking at each other. It is always permissible to move from the objective to the subjective mode in this type of presentation, but having once made such a transition, it must be sustained to the end of the sequence.

Another method of handling an interview situation subjectively is to set up over-the-shoulder shots from the reporter's and/or the interviewee's position. This creates matched reverse shots so that the camera becomes the substitute for the individual being talked to; hence, the audience senses that it is being addressed as well as the individual over whose shoulder the shot is being filmed.

The POV audience placement mode describes an audience's placement within the action, immediately next to a particular in-scene person. Therefore, the audience perceives whatever is the viewer identifies himself with this individual, since he feels that he is sharing an essentially natural experience.

Technically, the POV treatment is *objective* in the respect that the audience remains in the position of observing the action, but this view of the action is so nearly identical with the *subjective* experience of the companion performer that it brackets both modes. POV audience placement is extremely useful in training film applications, because it *psychologically* puts the viewer, with the aid of an expert, into a performance-type experience.

A critical aspect of POV filming concerns matching eye angles, and great care must be taken to accomplish this correctly. Our daily, real-life experiences have conditioned us to be aware of the precise spatial (dimensional) point being seen by others. We are remarkably accurate in estimating the location of this point by the position of the eyes of the individual being observed. In filming, if the relative spatial positions of people and objects have been established within a scene, we will instinctively estimate the eye angle necessary to see them from any location included in the shot. Therefore, if the eye positions observed in a film do not coincide with the viewer's eye angle estimates, he will immediately recognize that fact and be distracted by it. Since POV positions the viewer directly beside a reference individual in a known location within a scene, it is necessary to specifically direct the proper eye angles for all performers appearing in POV sequences. Be sure anyone supposedly looking at the performer next to the camera does not look directly into the lens, nor off to the wrong side of the camera—either is a disaster.

We are constantly aware of our own physical position within our environment. We can identify the placement of people and objects as they relate to our own location. We receive sensory information concerning our vertical and horizontal alignment. Our vision perceives depth, as well as width and height. We can distinguish which objects are closer to, or farther away from us than others. We have systems to indicate right and left and up or down. In a real-life experience, our comprehension of where we are in relation to what is happening around us is a self-explanatory matter. Unfortunately, the experience

environment wherein our elaborate self-orientation apparatus does not function. Therefore, *visual clues* must be provided within the film to assist the viewer to understand his physical position in relation to the action. This essential orientation information is interpreted by the viewer from *image size*, *camera angles*, and *camera height*.

Personal viewing experience has conditioned us to interpret the size of an image as an indication of the distance from our viewing position to the image source. Any progressive change in image size translates into evidence of a change in this distance relationship. If the image gets larger or smaller, we assume we have moved or the source of the image has moved, or both have moved. The mentally selective human seeing process also relates apparent image size to changing levels of personal interest and/or curiosity. Therefore, the proportional size of the screen image is meaningful to the audience in interpreting visual information.

Perceiving depth involves simultaneous mental comparison of two images as seen from slightly different eye angles (a person with only one eye cannot "see" depth). Since film presents only one image, we cannot sense true depth information while viewing it. Similarly, our awareness of vertical and horizontal positioning depends upon receiving sensory information which becomes available only to use during an actual, personal experience. We do not have access to automatic position reference data while viewing film. Therefore, to perceive this depth and position information, the director must *show* us logical evidences of it within the film itself. This is accomplished by selecting a camera angle which reveals relative depth and position relationships. Unless a silhouette or outline effect is desired, the camera angle should always reveal some portion of at least two sides or planes of a subject. This has the effect of showing an object is not flat and it does have depth. For the same reason, a multiplane positioning of objects should be composed in most shots. By this, we mean that some reference object should be seen close to the camera with other reference objects appearing at several increasing distances farther into the background. By this type of staging, the director creates depth perception by logic. The viewer reasons: "If that thing is close to me, and those other things are farther and farther away, the same rationale is used in including converging lines in a scene to provide a depth reference. An example of this would be to film a scene from such an angle that a sidewalk, street, or highway would be included. The receding perspective of its width narrowing into the distance would convincingly portray the illusion of depth.

Selection of *horizontal* camera angles also affects the apparent speed at which the action is perceived. Action seen straight-on; i.e., directly toward and away from the lens, appears slower than the real-life condition. Action seen perpendicular to the camera line-of-sight; i.e., across the frame from side to side, appears faster than the real-life condition. Camera angles between these extremes affect the apparent speed of action proportionately.

Remember that the actual position of the camera lens in relation to the action being filmed determines the audience's point of view; i.e., it establishes the position of the viewer. In real life, we are most accustomed to seeing things from a standing or sitting elevation. A film representation of our POV from these positions is called level-angle, and must be made from a camera height above ground approximately equal to our normal eye height above ground. Level-angle of a seated person positions the camera proportionately lower than it would be if the person were standing. Level-angle shots tend to be less interesting and exciting than footage filmed from a higher or lower POV since they represent the most naturally familiar viewpoint. However, use of the level-angle is almost mandatory in the following filming situations:

- When shooting facial close-ups.
- When representing the subjective view of a standing or seated person.
- When objectively positioning the audience at standing or seated height.
- When it is necessary to preserve the parallelism of vertical lines.
- When it is necessary to factually record scientific or technical subjects without introducing perspective distortion.
- When presenting graphic insert material.

interpretation. A low camera angle, looking up to a subject, has the effect of increasing the subject's importance, strength, and stature. Subjects seen from an upward camera tilt automatically become dominant in the scene. A high camera angle, looking down on a subject, has the effect of diminishing the subject's importance, weakening its power, and reducing its stature. The apparent speed of action is also reduced in proportion to the degree of downward tilt. Action seen from overhead may require a frames-per-second rate correction (fast-action) to restore action speed to "normal" appearance. Therefore, when used knowledgeably, vertical camera angles have potentially important dramatic value. Conversely, accidental misuse of vertical views can be seriously damaging to visual understanding.

In theatrical film production, shots using a changing vertical viewpoint are often used to achieve special dramatic effect. These are described as boom or crane shots, because the camera is mounted at the end of a boom. The camera, and its operators, can be raised or lowered through a vertical range. Thus, one continuous shot can be started at floor level as a low-angle view, then elevated to a high-angle, and returned to level-angle at standing eye height. In the field, much the same effect can be filmed from a "cherry picker" type of overhead wire maintenance vehicle, but the smoothness of movement will not compare to professional boom footage.

The visual effectiveness of boom shots derives from providing the audience with a completely unaccustomed placement; hence, a novel point of view. In real life, human beings do not possess the capability of effortless vertical mobility. We cannot float skyward, fly about, hover, and gently descend at will, but a boom shot gives us the visual sensation that we can. However, in selecting any camera angle, care must be taken not to permit the shot itself to intrude upon, or to visually overpower the action. Boom shots are more likely to call attention to themselves than any other type of effect. They should be used only in filming action which, in itself, contains strong dramatic and attention-holding elements.

depth and relative position in a film; hence, at least two surfaces of a subject should be seen. Angle-on-angle (or angle-plus-angle) goes beyond such basic spatial orientation of the audience to provide a compound view. This is accomplished by selecting a camera position which produces both a horizontally and vertically angled viewpoint. In other words, a front and side plane of the subject is seen (the horizontal angle), but the camera's point of view is also sufficiently above or below the level-angle to reveal some part of the top or bottom surface of the subject as well (the vertical angle). This camera/audience placement produces the most "three-dimensional" illusion possible, and it is often both dramatically and aesthetically pleasing. Relatively dull scenes can be made much more interesting by angle-on-angle shots. Flat looking backgrounds are often rendered almost relief maplike by a compound angle that clarifies the relative locations of neighboring objects. For these reasons, angle-plus-angle shots are excellent for establishing scenes, documentary orientation, and many architectural filming applications.

Camera positions in which the vertical axis of the filmed image is deliberately angled or tilted are generally described as *dutch angles*. These dutch angles cause a remarkable psychological reaction in the audience. Our natural, vertical/horizontal sensory mechanism is inoperative as a spatial reference in viewing film, hence, we optically substitute the edges of the projected image for such reference. We assume that the sides of the screen represent the true vertical, and the top and bottom of the screen represent the true horizontal. Therefore, if an image is seen in a centered or tilted relationship to these edges, it places the audience in an off-balance position, spatially disorienting the viewer and causing emotions of apprehension and confusion. Dutch angles are often inserted to subjectively represent the vision of insane, sick, wounded, intoxicated, or drugged people, or to reinforce scenes denoting disaster, crisis, etc. Tilted angle shots evoke extremely strong audience involvement, and they *must* be used *sparingly* to avoid visually "crying wolf" excessively. It is also important to bear in mind that any tilt in camera alignment must be of sufficient magnitude to give the viewer the impression that he is about to fall,

or your effect will appear to be only a camera setup error.

Maintaining Continuity.—We have explored the directional function of audience placement—implementing the means to visually place viewers so that they will relate to filmed action. But it is not enough merely to place an audience so that it perceives action, unless the action itself is coherent. The ability of a film to show a story in intelligible terms depends upon the degree to which its continuity requirements have been anticipated, planned for, and effectively implemented. Establishing and preserving continuity within a film is the second half of the director's interpretive responsibility.

Previously we discussed the nature of film continuity and the elements and techniques involved in maintaining it. From time to time you should review these elements with particular attention to:

Planning continuity

Arranging sequences

Maintaining screen direction

Preparing overlapping action

Employing the elements of composition

Selecting meaningful camera angles

Determining special effects requirements

Introducing cut-ins, cutaways, inserts, and transitions

To fulfill your interpretive obligation to your audience you must constantly strive to prevent any element of confusion from entering the viewer's mind (unless confusion is deliberately injected for dramatic purposes). If the audience perceives some aspect of your presentation as obscure, illogical, or an occurrence without apparent cause, it becomes preoccupied with attempting to rationalize "what happened." As a result, the audience loses contact with the ongoing story development, until the entire presentation becomes meaningless. Typical sources of such audience confusion include:

- Uncertainty as to position in time, i.e., is the action taking place now, in the past, or in the future?

- Uncertainty as to physical location, i.e., is this action happening in the same place, or in some other place than the last scene?

- Uncertainty as to direction or route, i.e., is this action happening with some relationship to a consistent pattern of movement, such as a north, south, east, or west direction, left to right, right to left, up to down or down to up?

- Uncertainty as to identification, i.e., does this action involve the same person, thing, or situation that was identified previously?

- Uncertainty as to the correlation of any combination of time, location, direction, or identification factors.

To prevent such audience speculation, a basic principle of continuity is to *show the change taking place on the screen,* or to provide immediate visual evidence of the change within the related scenes. Note the word "immediate." The audience must not be permitted to even begin to wonder if it has made a correct assumption, since in its preoccupation, it may miss a delayed clarification.

For example, if a present point in time has been established and a flashback or flashforward will follow, there must be some time-associated visual reference included within the shots which identifies the nature of the change. Going from a close-up of a face in the present to a close-up of the same face at any other point in time fails to communicate the nature of the change. The departing shot should be filmed wide enough to reveal that the locale and clothing are contemporary. Thus, the arriving shot showing an Early American locale and frontiersman's clothing would leave no room for confusion as to whether a change in point of time had taken place.

The main source of confusion as to physical location is most often associated with excessive change in camera angles between adjoining shots. If no fixed reference object is seen in both the departing and arriving shots, they may appear to be happening in separate locations. Therefore, direct the cameraman to compose the shots in a known shot progression so they will include a series of fixed reference objects that will carry over between shot pairs. If this cannot be done, changes of camera angles must be kept relatively slight and must be carefully evaluated for potential audience disorientation effects. It should also be noted that inserting frequent reestablishing shots is helpful in defining location in potentially confusing situations.

Audience uncertainty as to direction or route normally reflects a failure of the director to follow rules for maintaining screen direction. Once established, the apparent direction of movement must be logical. For example, geographical directions of north, south, east, or west must conform to their map positions. If the action is represented to be moving northward, the consistent screen direction must be toward the top of the screen. Movement from Los Angeles to New York must consistently progress toward the right edge of the screen as the audience views it—west to east, left to right, etc.

Confusion about subject identification is frequently the result of consistently shooting too wide or tight. ECU shots of hands, mechanical or electronic components, instruments, or other details limit the audience's view of the reference environment to the point that the shots tend to lose identity. Similarly, extreme long shots compress the size of reference objects to the point that they cannot be recognized by the audience. The purpose of the establishing shot is to visually specify the locale and to reveal the relative positions and nature of objects within it. A breakdown in subject identification usually indicates shortcomings in structuring the establishing and reestablishing shots, or a failure to provide them at all. The obvious cure for this problem is to be certain the cameraman includes *positive* subject identification in establishing a sequence and to reinforce this periodically with good reestablishing references.

Audience understanding of the interrelationships of time, location, direction, and identification factors is the product of complete orientation within each of the factors. In other words, a viewer may be willing to temporarily accept a degree of uncertainty about one or more of these factors, but this will ultimately prevent him from being able to correlate the meaning of the entire production. For this reason, the only way you can feel confident your product is successfully communicating is to ensure there is no possibility of confusion in the viewer's mind concerning time, location, direction, or identification references. If each of these is effectively communicated separately, the audience will automatically combine them to understand the entire film. Conversely, failing to make even one of these details clear will threaten the overall understandability of the project.

## SPECIAL EFFECTS

Most of the special effects used in Navy motion pictures are added to the film in the laboratory during preparation of the print, not in the camera at the time of original filming. But since it is possible to produce some effects in the camera, we will discuss the general principles through which some of them may be achieved.

### Fade-Out

A fade-out can be accomplished quite simply in the camera. The fade-out is usually placed at the end of a related series of sequences. It provides a transition to a completely different sequence. To produce the fade-out in your camera, you slowly stop down the diaphragm to its smallest opening and the screen gradually gets darker until nothing can be seen. Fade-outs are most successful if you start with a fairly wide aperture, unless your camera is equipped with a mechanical fader. A fader is simply a spring-wound extra-equipment diaphragm that can stop down until all light is excluded from the film. As the fade is projected on a screen, you see a scene that gradually gets dimmer and dimmer until it completely vanishes from the screen. The usual procedure is to follow the fade-out with a fade-in of the next scene.

In cameras equipped with a variable shutter degree feature, the fade-out/fade-in is normally accomplished by gradually reducing or widening the effective shutter opening until it is either completely closed or opened respectively.

### Fade-In

From its name it is obvious that this effect is the opposite of the fade-out. You accomplish the fade-in by opening the diaphragm (or shutter) from fully closed to the correct f/stop. The dark screen gradually becomes brighter and discloses the new scene. Thus, the fade-out fades the old scene from the screen and can be followed by a fade-in which fades a new scene onto the screen. This effect is especially desirable when the sequences are not closely related and when you must account for a considerable time lapse.

### Dissolve

A dissolve is basically the same thing as a fade-old scene so that the screen never goes dark. The technique is to first shoot the fade-out at the end of the scene, then reverse the camera, or backwind the film manually (while the shutter or aperture is still closed) to the point at which the fade-out began. A fade-in of the new scene is now started at that point. The effect on the screen is that of a double exposure where one scene gradually disappears while the other gradually appears.

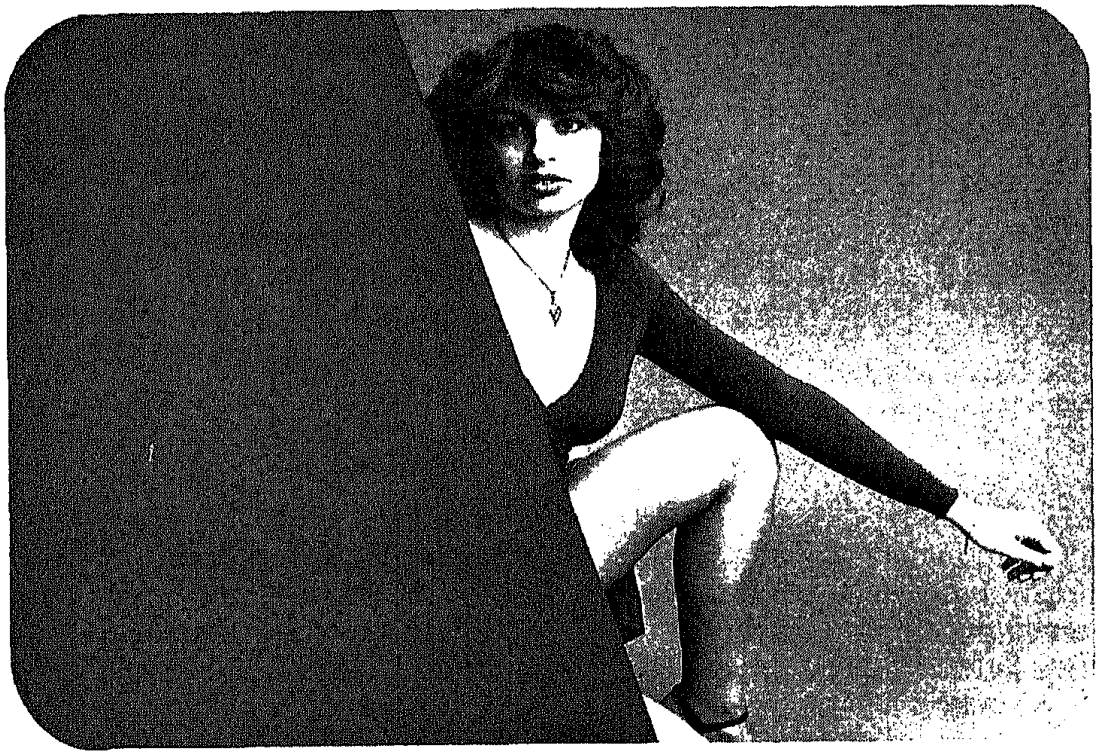
### Multiple Exposure

At first thought it would seem rather foolish to deliberately make a multiple or double exposure. However, it is done very often for trick effects. Have you ever seen motion pictures in which an actor talks to a semitransparent ghost? Or, have you seen an actor playing a dual role? These are but two examples of deliberate multiple exposure. You can produce the ghost image in much the same manner as the dissolve except that you do not use the diaphragm. You shoot the first scene normally; then you backwind the camera. When you start the camera your new exposure is literally placed on top of the old one. It usually helps if your background is dark or even black when you film the first image. Otherwise, the rest of your background may also have a ghost image. When you photograph an actor in the scene with himself, you use a black masking device installed in a matte box (a device for holding masks) mounted on the front of your camera. This masking device prevents exposure in one area of your film while recording an image on the other. If this sounds simple, remember that the angle and position of the camera are very critical, especially in the case of an actor talking to his own image. If you use the wrong angle, the two images overlap in the wrong spot and completely ruin your effect.

### Wipe

In this effect one scene "pushes" another off the screen. By using optical printers in the laboratory this effect is simple to obtain. A *true* wipe is rather difficult to make in the camera. Since one scene replaces the other on the screen, at the halfway point in the wipe, one-half of each scene should be on the screen. This is almost impossible to do in the camera. The only wipe you can accomplish in your camera is to completely

**A print wipe. One image "pushes" the other image off the screen.**



"print-wipe" is preferred.

To produce a "camera-wipe," slowly draw a piece of black cardboard across the front of your lens. This gradually cuts off the image of the scene you are filming. You then bring the next scene in by gradually uncovering the lens in the same manner and in the same direction as you did in the cutting off procedure. For best results, mount a matte box on your camera and cut the black cardboard so it fits into the tracks on the matte box. Now you can smoothly slide the cardboard across the front of your lens. To produce the most effective wipe, you must, as we said, *wipe off* and *wipe on* in the same direction.

**Animation**

Animation is the technique of producing "motion" in inanimate objects or drawings. It is not something you normally do without training or specialized equipment. In the context of this module it is considered "specialized photography" and is discussed in greater detail in chapter 4.

> In using any filming technique in which a 16mm camera is operated in any manner which will later require that the film front-to-back position be physically reversed (turned end for end), be certain to use double perforated film. If double perforated film is not used, it will be impossible to run the film with the emulsion on the proper side because the sprocket holes will be on the wrong side of the film.

**Weather Effects**

Weather effects are usually reserved for larger well-equipped studios, but you may be interested in some experimentation along these lines.

You can produce snow effects by sifting plastic snowflakes down onto the set. If sifted gently, this gives your scene a tranquil effect. If you want to show a storm, the "snow" can be driven across your scene by an electric fan. You can simulate rain by simply allowing water to drip down on the set through a pipe with a number of holes drilled along its length. When you simulate damaged by the water. It might be better to allow the water to drip down between the camera and the set. This way, the water can be caught in some sort of container and drained off. If this system is used, don't forget the entire set should appear to be wet, or else the scene may look unrealistic.

Lightning is rather easy to simulate by flashing lights on and off. Or you can use the still photographer's electronic flash. Be careful you do not overdo the effect. Keep the light away from the camera lens and try to vary the intensity of the flash from time to time.

One of the easiest weather effects to produce is fog. Carbon dioxide gas escaping from dry ice produces an excellent fog effect. You can blow the fog with a fan. Be careful the airstream is not too strong, or the gas will be dissipated too rapidly. CARBON DIOXIDE GAS WILL NOT SUPPORT LIFE, so when you use dry ice, PROVIDE AMPLE VENTILATION. This artificial fog can constitute a safety hazard. It might be a good idea to check with the appropriate safety and medical officials before you use this technique.

**Models and Miniatures**

By the careful use of models and miniatures, you can create scenes too costly to build full size. Usually you show the miniature set scene in a long shot so too much detail isn't present. Your long shot provides the locale and then you shoot the remainder of the action on a full size set. This technique is especially valuable when the scene must be destroyed by fire, flood, or bombing. On many occasions, models are used when the real article cannot be on hand or the cost of obtaining it is prohibitive.

**Transitions**

While they are not special effects in the true sense of the word, transition shots are scenes that help the audience bridge gaps in time or distance. There are many forms of transition shots, and with experience you will develop many of your own. A good example of time transition (often used when the cameraman wishes to jump over a period of a year or so) is to cutaway to a calendar on the wall as the pages fall away until a year has elapsed. Or the *distance* transition where an automobile must quickly go from one state to another and the cameraman films a

use to fill in for a time or distance gap. This way you still give your audience all the information it needs to follow the progression of events. You may think of these shots as cutaways—as they are indeed. But, in this specialized form, they are properly referred to as *transition shots*. In any event, try using them and notice the improvement in your work.

Another good form of transition is a special application of the fade. When your actor goes out through a door, have the door close in the "camera's face," thus blanking out the screen. The next scene can be started by having the actor stand with his back to the camera so his back covers the lens. As the actor walks away from the camera, the effect is that of a fade-in. You also have the added advantage of a transition shot.

### Buildup

The term "buildup" in motion picture photography simply means building up to a climax in the story. In some situations this is not too difficult since the buildup is completely natural and you can photograph it as it happens. However, there are many cases in which the main action cannot be filmed. Take for example an aircraft crash. It must be *suggested* since it cannot be shown in the sequence. Let's presume that you are shooting a semidocumentary film and its climax is built around the crash of an aircraft. It would be almost too much to expect you to be on the spot to film an actual crash. Therefore, your story has to consist largely of buildup since the real climax is missing. The buildup in this instance could be various scenes showing aircraft, similar to the one that actually crashed, taking off and in flight. The flight scenes could be followed by a number of scenes showing the strained features of a control tower operator trying to contact the downed aircraft over the radio. You can take some shots of a map with someone's finger pointing out the probable crash site. This helps to create additional buildup. At this point you could also film some of the preparatory action on the part of a rescue team as it gets ready to go to the crash site. Some scenes showing snow weasels being prepared for the trip, or helicopters being fueled and loaded before they start for the site, all add buildup to your movie. which is the real topic of your film, is supplemented through the effective use of buildup without actually showing a crash. As you gain experience, you will use the buildup technique more and more to add interest to your stories.

## SOUND MOTION PICTURES

Combining photographs and sound to create a sound motion picture represents a most unlikely possibility. Sight and hearing share no common denominator, except that they are both among the human senses. They function through entirely different principles, requiring entirely different apparatus. Yet, they can both be physically combined on a single piece of motion picture film to effectively duplicate a real-life experience.

Sound is a type of mechanical energy moving outward from its source in the form of individual pressure waves. Each pressure wave represents a cycle of the original vibration. If this force (energy) is used to accomplish some *mechanical work* that will mark the passage of each pressure wave, it will produce a *record* of the composition of the *original vibration*. Using the *energy* of the sound pressure wave to actuate something to make a permanent mark on some physical material each time a wave occurs is known as sound recording. We have developed many different methods of accomplishing a record of the action of sound waves, but in each case, the fundamental requirement of making the *energy* of the wave do some form of *mechanical work* to actuate the means of marking its presence remains.

The other fundamental requirement of sound recording has to do with maintaining a rigid speed/time relationship between sound wave frequency and recording/reproduction mechanical speed.

If we place marks representing sound waves on a recording medium, the *physical distance* separating each mark from the next reflects the *length of time* that originally separated the vibration cycles that caused the sound waves. These marks, called *modulations*, represent the *frequency* of the original vibrations in terms of *distance* or *surface speed* related to cycles per second. Any change in the surface speed *after* the sound wave marks or modulations have been made will change the frequency of the recorded

closer or further apart in *time* than when they were recorded. It is *essential* that the surface speed of the material recorded upon be *consistent* and that the playback surface speed be *identical with it*. This requirement of maintaining a fixed speed relationship between the recording and playback apparatus is called *synchronization* (sync). In the case of sound motion picture films, the camera, sound recording, and sound playback equipment must be in synchronization. Synchronization is the essence of sound motion picture production.

In nonfilm sound recording, you are concerned only with keeping the speed of the sound *recording* surface and the speed of the sound *reproducing* surface the *same*. The factor determining what this speed must be relates to moving the respective surfaces fast enough to provide adequate separation of the modulations. If you are recording a 15,000-cycle vibration, you must have enough space to make 15,000 separate marks (modulators) on the recording surface to represent this sound. Therefore, you must provide enough surface speed to be able to physically record 15,000 modulations in a length of the surface that will run through the recorder and playback apparatus in 1 second. This required amount of space varies between the different recording systems and materials. In a pure sound recording context "*synchronization*" relates only to exactly preserving this arbitrary recording speed and playback speed relationship.

Recording the sound in a motion picture is much more complex. Here, synchronization involves a third factor. This third factor concerns the pictures and the required lineal speed of the physical strip of film containing them. This length/time relationship is *absolutely fixed*, because of a different consideration which has nothing to do with sound. But it does have to do with persistence of vision. We must show 24 pictures in each second, or we cannot create a standard motion picture. Therefore, in recording film sound, the physical length of a piece of film capable of containing 24 frames of pictures for each second of running time also dictates our sound recording/playback surface speed. Maintaining this exact relationship is the nature of motion picture sound synchronization. In sound motion pictures two basically incompatible forms of physical movement are involved in the same piece of material containing both the pictures and the sound. In module 2 of this training series, you both in the camera and projector, is essential to producing an illusion of motion. We stated that it is essential to maintain an absolutely *consistent* surface speed if we are to achieve acceptable sound recording/reproduction quality. These two motion requirements, one relating to the picture portion and the other relating to the sound, could not possibly be of more opposing character.

**Picture Sound Placement**

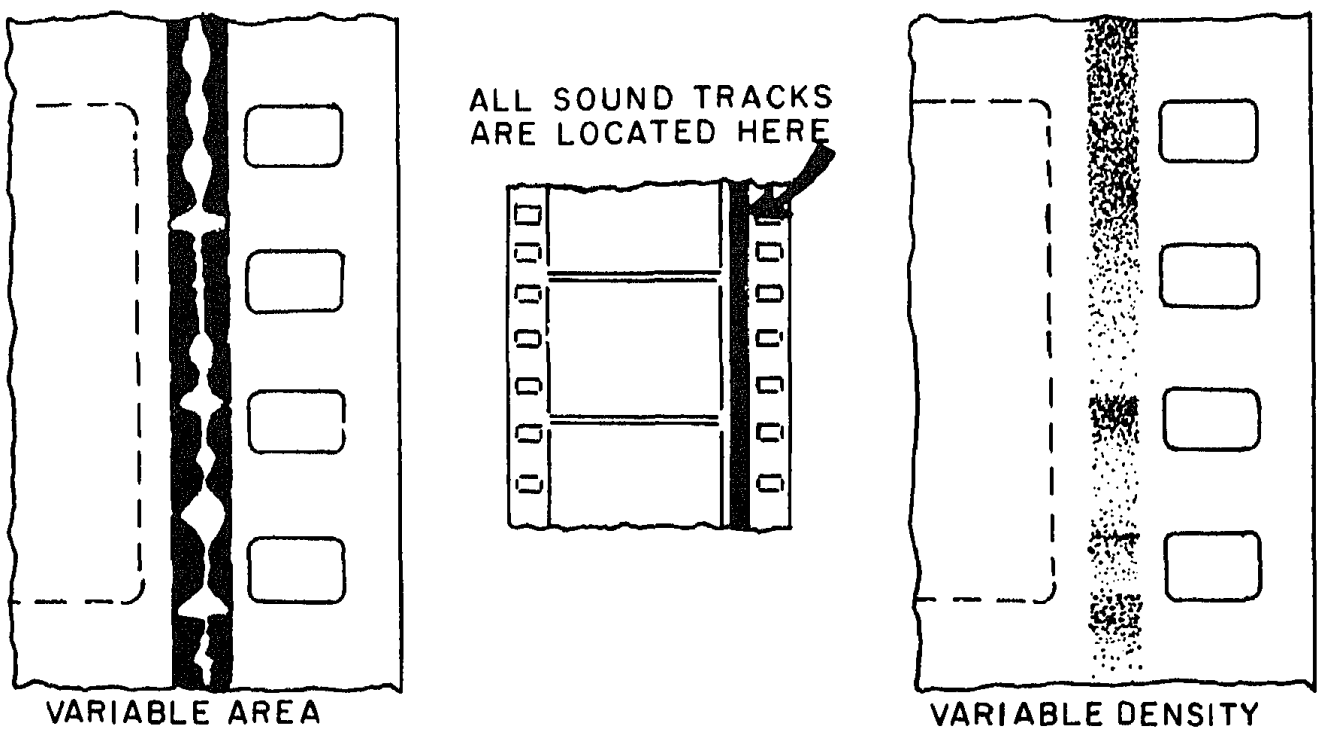
As you know, a standard motion picture camera and a projector produce intermittent film movement at the film gate aperture in order to record, and project, respectively, the visual image. However, sound recording requires that the sound recording medium be moved constantly through the sound reproduction source. The solution is to extend the bottom film loop in both the camera and projector. This allows the intermittent "flutter" of the film to "settle down" before reaching the sound recording head in the single-system camera or the sound reproduction source in the projector. Motion "damping" systems act upon this extended lower loop to convert the film flow to a constant (nonintermittent) speed before the sound processes occur. If any residual film flutter actually reaches the sound recording/reproducing point, the sound will "wow" and be unacceptable. Therefore, bottom loop setting must be accomplished *precisely* in threading any sound film equipment. To provide the film length necessary to stabilize intermittent movement, yet keep the sound and picture in sync, *optical* sound is placed 26 frames ahead of the matching frame of picture. In the case of *magnetic* stripe sound tracks, this sound-lead or sound-advance is increased to 28 frames ahead of the matching frame of picture. (As we shall discuss later, this sound track leading requirement can create editing problems.) Any discrepancy of more than *two* frames (ahead or behind absolute sync) is noticeable in lip-synchronized sound sequences. This "out-of-sync" condition may be caused by improper synchronization of the original camera/recorder, and editing error; incorrect placement of the sound-lead in making the print; or carelessness in forming the bottom loop in the camera or projector. Whatever the cause, out-of-sync film is objectional and unprofessional. Every effort must be made to prevent it or, if possible, to correct it before the film is shown.

**Sound Recording**

The two primary sound recording methods are *optical sound* and *magnetic sound*.

OPTICAL SOUND RECORDING.—Optical sound recorders built into "single-system" cameras use a recording galvanometer apparatus. A galvanometer is a very small magnetically actuated movable mirror, associated optical system, and constant intensity light source. Magnetic impulses produced by microphones from sound pressure waves cause the mirror to move. This action directs the rays from the constant intensity light source through a narrow slit and onto the film sound track area. The light exposes the film emulsion in relation to the modulation characteristics of the mirror movement. This method is used to produce single-system optical sound and is the basic method of introducing the optical sound track onto the final composite print. It has the inherent limitation of being unable to accommodate as great a number of modulations as the same length of magnetic oxide recording material. Therefore, it is not capable of achieving as high a degree of sound fidelity as magnetic recording. There are two different systems of optical sound tracks—*variable-density* and *variable-area*. Each has its own merits. Variable-density recording requires than does variable-area, because the latter system merely prints modulations in black and white. Variable-density recording, on the other hand, requires correct graduation of tones over a wide range. In other words, variable-area recording only changes the *area* of the film sound track that is being exposed, while variable-density recording changes the *density* over the entire width of the sound track to record the modulations. From this you can see that while variable-density is difficult to control during processing, the variable-area recording amounts to developing a black and white line "scribble."

One advantage of the variable-area system is it is less likely to record background noise caused by the graininess of the film emulsion, especially at higher densities. In addition, sound track cutters (editors) prefer the variable-area sound track because the modulation is much easier to see and, therefore, easier to cut. On the other hand, variable-density sound recording also has advantages. Variable-density sound track is much less susceptible to background noise that results from pinholes and scratches in the positive print. Also, when correctly processed, variable-density tracks have smoother overload characteristics, which minimize distortion when the volume is turned up to high levels.



applications as in magnetic recordings of any other type. Electrical impulses from microphones actuate magnetic fields, causing magnetic patterns to be formed within the oxide coating on the film. Magnetic recording equipment is used in the production of most motion picture sound. It is applicable to all the processes leading to the preparation of the final composite print. At that point the master magnetic track sound is usually fed into an optical recording galvanometer to produce the master optical printing sound track. This, in turn, is used to accomplish the photographic composite film printing process. Single-system magnetic recording is common in news, sports, and special event sound filming. This system uses a small magnetic recorder placed inside the camera. Sound is recorded upon a magnetic "stripe" deposited on the film surface in the normal sound track area. The stripe is actually a narrow coating of the same material used in forming the magnetic surface of audiotape and is used in exactly the same way. This stripe may also be applied after the film has been processed and edited. This makes "post-recording" possible—as in the case of narration to be added after the picture portion is completed.

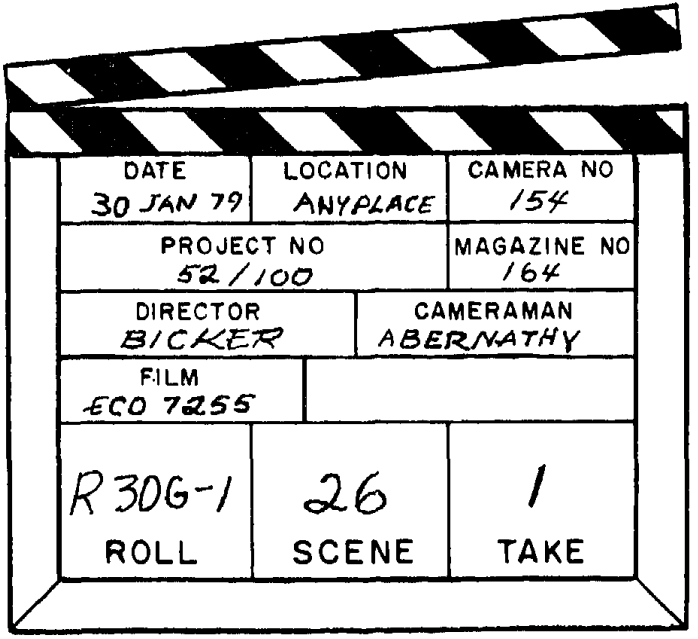
## Single-System Versus Double-System Recording

The fundamental distinction between single- and double-system film sound processes is whether or not the sound track is produced on the same piece of motion picture film as the picture *and* at the time of original filming. If both sound and picture result on the same piece of film at the time of filming, the method is the single-system. If physically separate picture and sound recording materials are used, the method is the double-system. Whether the resulting sound track is optical or magnetic is not a consideration in this context. *Any* camera capable of being operated in synchronization with a synchronous sound recorder is potentially a double-system camera, since it is possible to use that camera in conjunction with the recorder to make synchronized separate picture and sound. Any camera with provisions to also record sound on the same piece of film at the same time as it is used to film pictures is a single-system camera. Since single-system cameras are driven by synchronous motors, they also are automatically conjunction with a synchronous sound recorder and will maintain picture/sound synchronization. There is no requirement that a single-system camera must always be used in the single-system configuration. In fact, it is desirable under certain circumstances to use the camera to make the normal single-system track at the same time a separate synchronous recording is being made. In such applications the single-system camera is actually being used as both a single- and double-system source.

SINGLE-SYSTEM SOUND.—Because of the difficulties in editing caused by the difference between camera and editorial synchronism (26 frame lead in optical tracks, 28 frame in sound stripe) and various processing disadvantages, single-system optical sound has been almost abandoned in favor of double-system for major productions. About the only exception is in the field of newsreel coverage, where single-system sound has many advantages. The biggest overall advantage of single-system sound is its simplicity.

Films you produce using single-system *optical* sound methods contain two photographic exposures: one is for the picture and the other for the sound track. Depending upon the type of optical sound recording system in the camera, the sound recording will take the form of either variable-density or variable-area modulation images. Since both the picture and sound recording are contained on the same piece of film, they must both be processed at the same time. Unfortunately the best processing techniques for the picture portion of the film do not produce the best sound track image. If processing is modified to produce the best sound track image, the picture image will be degraded. This inherent relationship is one of the basic drawbacks of the single-system optical sound method. Moreover, the sound track lead is "built in" to the relative positions of the picture image and the corresponding sound modulation marks. Therefore, picture and equivalent sound cannot be aligned for editing purposes. This creates difficulties for the film editor, since he must devise some means of "covering" a 26 frame (28 frame, in the case of sound stripe) picture/sound discrepancy every time he makes a cut. Single-system method serves a useful purpose and your responsibility is to produce good film using this method when required.

for deciding that single-system sound is preferable for a particular story. There may be a shortage of personnel and you and the soundman can handle the job nicely. Or, since automatic synchronism is assured when the picture and sound are recorded at exactly the same time and on the same material, and can't be out of sync, this method is very useful. Finally it is the fastest way of getting both sound and pictures on a piece of film. Suppose the film you shoot is to be released to the public on a television newscast on the evening of the same day you shot it. If double-system sound had been used, chances are the film would not get to the TV station on time. If you have a lot of time to produce a motion picture, you should usually use the double-system method—especially if the highest quality sound is needed.




DOUBLE-SYSTEM SOUND.—In this system of sound film production, the camera and the sound recording system are separate units operated synchronously. Whether the sound is recorded by optical or magnetic means, the sound track and the picture film represent two different pieces of material; one containing the sound portion and the other the picture portion. These remain physically separate throughout the production operations and are combined only in the final composite print. The overall advantages of this method are in its production and editing flexibility and superior sound quality.

Double-system sound is used for motion picture productions that require extensive editing; for example, when you must do considerable out-of-sequence photography. Double-system sound reproduction produces high-quality sound. The reason is that since the picture and its sound are separate, the pictures can be processed for optimum photographic properties and the master optical sound track can be recorded and processed as high-contrast film which would be unacceptable for picture purposes. Sound only recording film is especially designed for this purpose and requires special processing. Eventually when picture and sound are brought together in the print as a single length of film for projection, the sound and picture are in sync and both have retained their most desirable properties. Since sound and picture are edited separately, there are no dead spots (picture without sound) as there are in edited single-system sound tracks.

Clapstick.—To assist the editor in the production of motion pictures of professional quality, you will use a slate equipped with a "clapstick" along the upper edge. You already know that the slate helps the film editor to identify rolls and scenes; the clapstick aids him further.

The motors in the camera and the sound recorder must run at exactly the same speed; however, at the very start of operation they are not in synchronism. To correct this problem, the camera and the sound recorder are allowed to run for a few seconds to build up to proper operating speed. When you are ready to film a scene, your assistant bangs the clapstick down on the top of the slate and announces the scene and take number as written on the slate. The clapsticks provide a sync mark for both sound and picture at the beginning of each scene.

Editing sync marks produced by the clapstick guarantee synchronization. Because the camera photographs the meeting of the clapsticks, the single frame showing the point of contact is readily found by viewing the picture. The sound appears on the optical sound track film as a cluster of fine lines produced by the sound of the clapstick hitting. In magnetic sound tracks, the "clap" must be found by its sound, then be physically marked on the track material as a reference point.

In editing, the frame showing the point at which the clapstick came together in the picture is aligned with the "clap" modulation marks on the sound track. Thereafter, the two pieces of material will remain in sync, provided they are

accomplished in the editing equipment (the viewer, for seeing the picture and the reader, for playing back the sound) by mechanically coupling the units together, so both must move equally. The editor is thus able to make his cuts "straight-across" (at the same point in both the picture and sound track). This eliminates the problem of cutting through the sound advance that makes single-system sound difficult to edit. For purposes of making the print after the production is completely edited straight-across, the whole sound track is advanced in relation to the whole picture. Therefore, if the straight-across editing is accomplished accurately, and the advance is properly set into the print, and the projector loop is precisely formed, the production will be "in sync" when it is seen on the screen. Without clapsticks, there would be no precise reference point from which to begin the whole synchronizing process.

In some contemporary cameras, an electronic accessory is used to perform a synchronizing function equivalent to the clapstick. This apparatus marks the picture film with a light ("flashes a frame") at the same instant that it transmits an electronic "beep" tone to the sound track recorder. To set up sync for editing, the flashed frame is aligned straight-across with the sound track "beep" in exactly the same way as the picture and sound of the manual clapstick.

## MOTION PICTURE EDITING

Motion pictures are made up of "parts," much like watches, automobiles, and countless other manufactured items. In order for a film to function, its components must be arranged and assembled to interact collectively on a systematic basis.

Film *parts* are complete scenes of pictures, partial shot sequences, individual shots, titles, and optical effects; together with related dialogue, narration, music, sound effects, and background sound tracks. Ultimately, these parts of the total production must be reviewed, identified, sorted, selected, assembled, and combined to form a cohesive motion picture. This overall process and function is called editing.

In formal, studio-type motion pictures, editing is a complex procedure that is normally accomplished by one or more professional film editing specialists. In the absence of an editing specialist, you may be called upon to perform fundamental editing functions on your own camera footage.

from the time the processed camera original is printed until the final edited version is ready for distribution. Your job starts when the film has been shot and processed. You use techniques and creativity to give the film a definite pace. Not many films are shot in the order in which sequences or scenes are to appear in the finished production and many scenes are shot more than once. Your first job is to sort or cut out the right scenes and the best takes and arrange them in the proper sequence or script order. Next you fine cut the assembly, cutting or changing from scene to scene at the most advantageous point. The sound track(s) must also be cut and matched to the edited version of the picture.

Editing the film is an important part of the entire film production process. The editor can cause the time and effort of the film crew that shot good footage to be a waste if he puts the scenes together poorly. On the other hand, poor footage produced by the shooting crew can often be improved by skillful editing.

### Editing Equipment

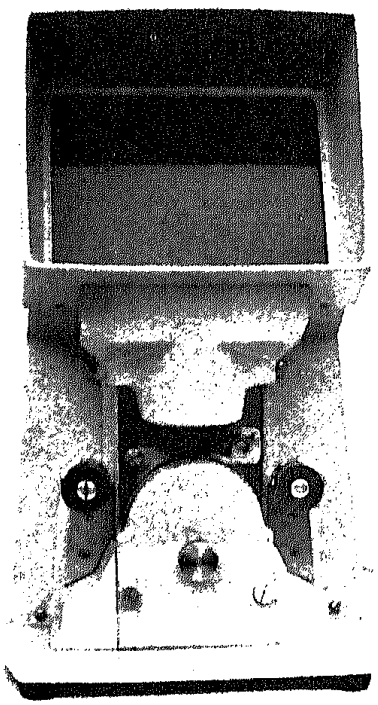
Film editing is a refining process and since a physical substance is involved (the film itself), physical things must be done to it to accomplish the refining process. In essence, these things consist of physically cutting out the undesirable materials, then physically joining the remaining desirable elements together again. Unfortunately, the nature of film is such that what is desirable or undesirable is not a matter of some clear-cut standard. A shot may start out in one category and, as it progresses, end up in the other, so the cutting out and joining together is not a once-through operation. Typically, film editing proceeds in several stages, each intended to get a little closer to 100-percent desirability—but carefully controlled to avoid accidentally cutting out some portion of desirable material. A film is normally edited a number of times before the final cut is accomplished. Each of these preliminary versions is called a rough-cut, until the last one actually becomes the final, edited film. Moreover, different sections of the film may be rough-cut as separately assembled units, then joined together with others, only to be rough-cut again and again, until the whole film has been brought together.

This is a repetitive operation. Bits of film are joined together, viewed, cut apart, trimmed, rejoined, viewed, cut apart, another shot added, and rejoined, time after time. Specialized tools

and facilities are essential to make it possible to perform these mechanical steps accurately, rapidly, and with a minimum of frustration.

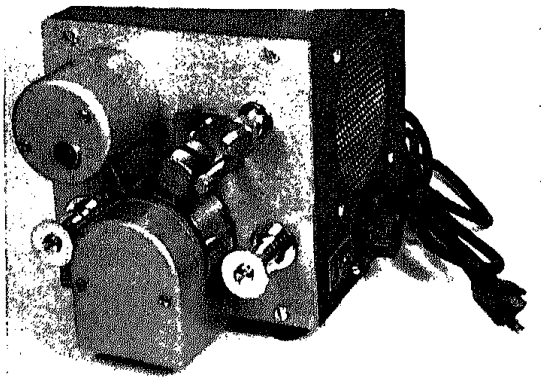
First, there must be provision to critically view the action of filmed images. If there is accompanying sound, there must also be a means of hearing it in synchronization while viewing the image action. Second, there must be a way to move the film and/or sound track through the viewing and sound reproducing apparatus in either direction. This is necessary to select an exact editing point. Third, there must be a means of cutting the picture and/or sound materials apart and joining them back together again at the precise location selected. We can describe and identify the essential tools for editing, as follows:

- *A device which makes it possible to see the action of filmed images.* This is called a viewer, or more properly, a motion viewer. It must be capable of showing the motion of sequential images. A viewer consists of a light source and an optical system which enlarges the images and displays them to the editor as film is passed through the mechanism. Viewers must be able to run in forward and reverse directions, so image action may be evaluated in either direction until an individual frame can be identified as the cut point.



*Courtesy RTI Research Technology International.*

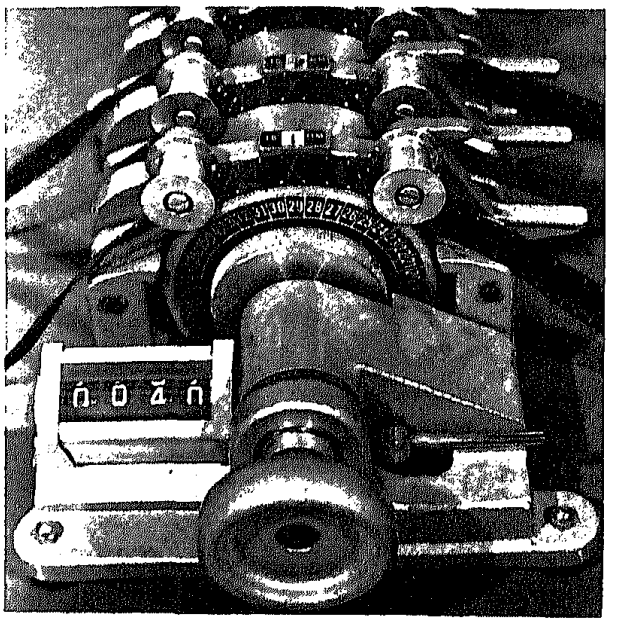
- *A device which makes it possible to hear sound recorded in sound track material.* This is called a sound reader. It consists of a compact amplifier and speaker actuated by optical/magnetic sound pickups, thereby playing back the sound from track materials as they are passed through the mechanism.



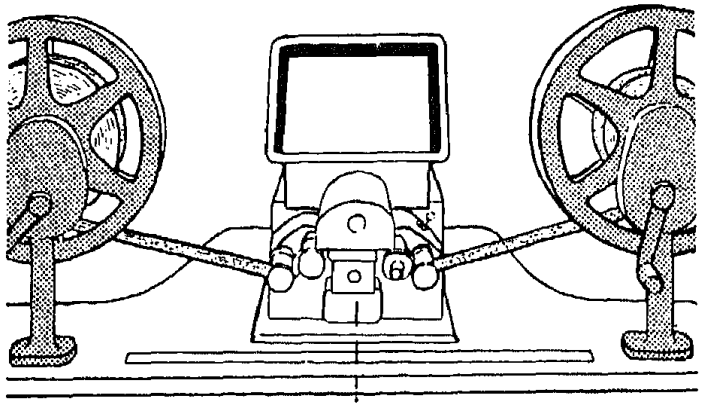
*Courtesy RTI Research Technology International.*

**Optical/magnetic sound reader.**

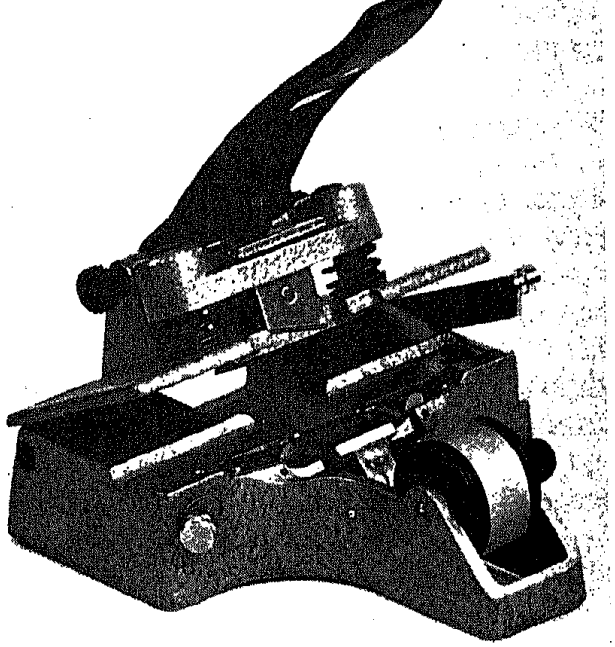
- *A device which maintains synchronism between separate picture and/or sound materials.* This is called a synchronizer. It consists of a gang of at least two, but often as many as ten, sprocketed wheels in which standard film perforations are engaged and clamped in place. Each wheel can be mechanically coupled to the others, causing them to rotate together and maintain identical lineal relationships as perforated materials are moved through the mechanism.



● *A device which moves one or more strips of picture and/or sound materials in either horizontal direction.* This is actually a pair of units called rewinds. They consist of gear-driven spindles actuated by handcranks or motors. One or more reels of picture and/or sound material can be mounted on the spindles and be wound from one unit to the other. The other devices described above are placed in the path between the rewinds, so that picture and/or sound materials may be drawn through them as it is wound from side to side by the rewinds.

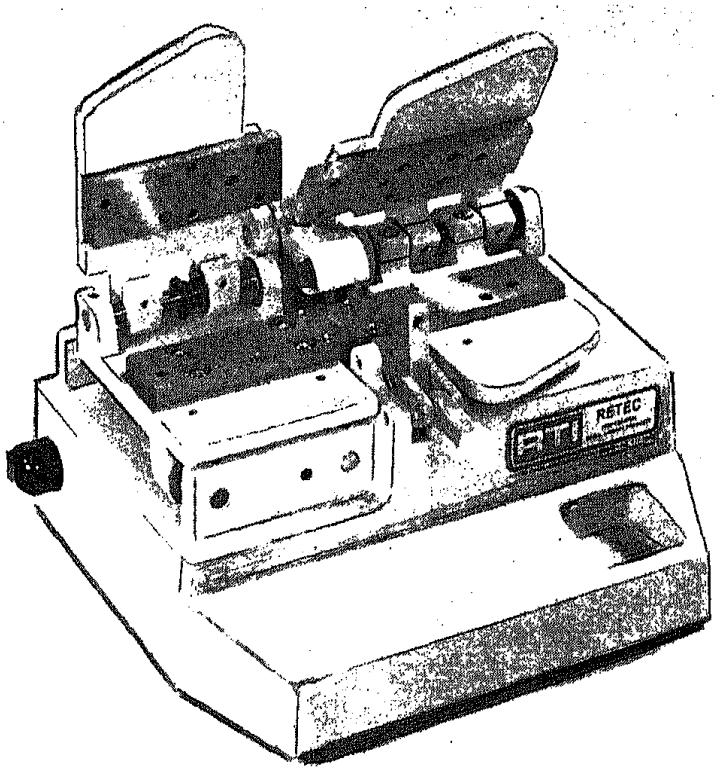


● *A device which clamps picture or sound material in position and either cuts it apart, or joins it together at the precise selected point.* This is called a splicer. There are several forms of splicers, because different methods of joining the materials are employed. Pressure-sensitive tape is used in some cases, solvent cement or a combination of cement and heat are used in others. Essentially, all splicers consist of an alignment channel to accurately position materials to be cut or joined and provision to hold the separated parts during whatever joining method is used.



*Courtesy RTI Research Technology International.*

**Motion picture film tape splicer.**




*Courtesy RTI Research Technology International.*

**Motion picture film hot (cement) splicer.**

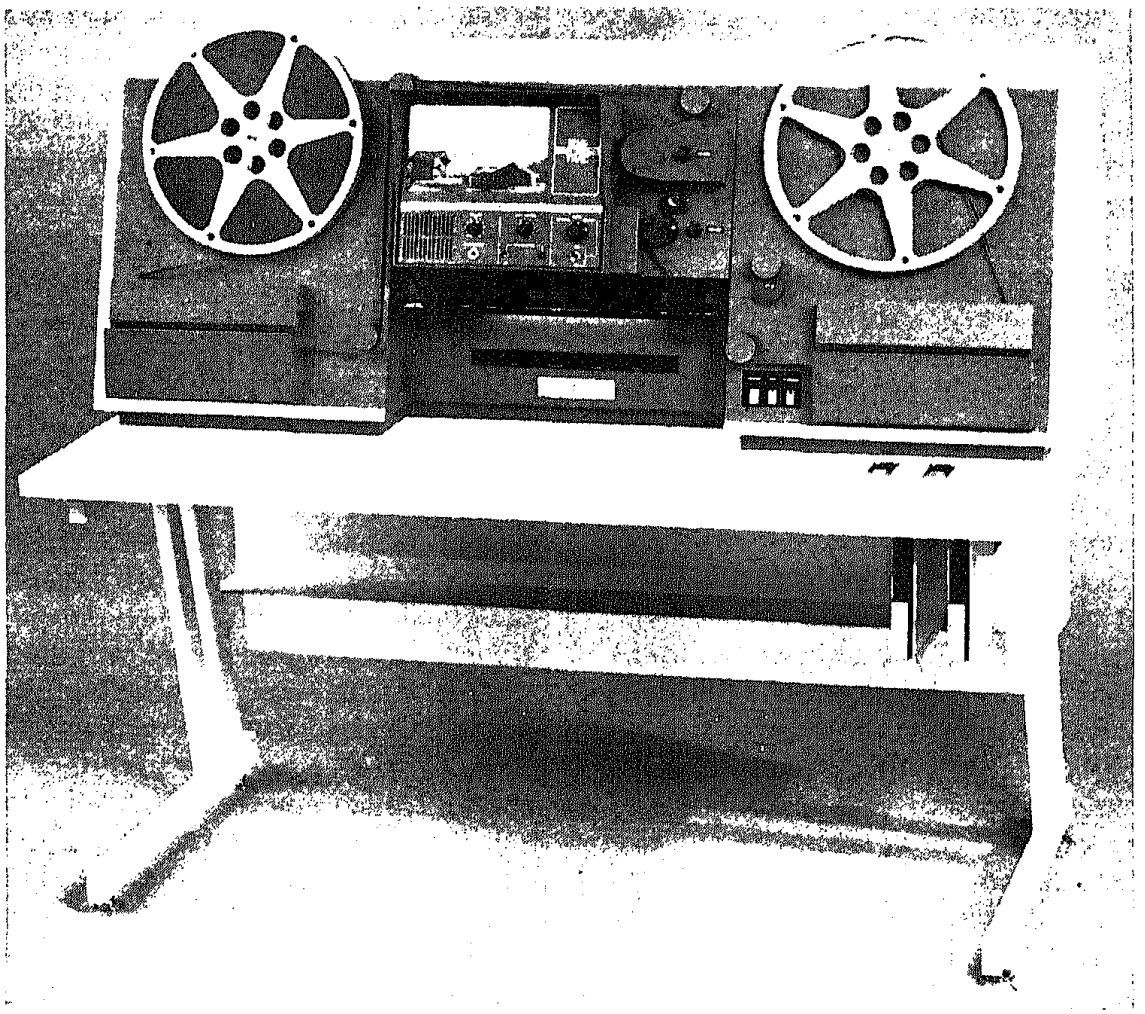
There are only five basic functionally distinctive items of film-editing equipment. All other editing machines perform some combination of the functions of these separate items. For example, a film-editing *system* apparatus permits viewing picture, hearing sound, maintaining synchronization between picture and sound, picture and picture, or sound and sound and, in addition, moves picture and sound materials in either forward or reverse directions at variable rates of speed. It serves all editing functions except that of the splicer. However, the basic editing tools above are entirely adequate to accomplish any normal assignment. The specific operating manual for the type and model of editing equipment you will use should be carefully studied before attempting to operate it.

**Fundamental Editing**

The original character of a filming situation influences all subsequent editing functions and objectives. For example:

- In a fully scripted production, the basic purpose of the editor is to translate various "prefabricated" film parts into the visual interpretation of a previously written description.

- In documentary/ceremonial productions, the basic purpose of the editor is to re-create, from the film coverage provided, a realistic and comprehensive visual representation of the actual event.



*Courtesy RTI Research Technology International.*

**Motion picture film editing system.**

is to perceive and assemble, from the film coverage provided, the most visually meaningful story that can be created.

CONTROLLED ACTION.—Controlled action implies that the individual parts necessary to assemble a meaningful film have been determined and described in detail in the script before they have actually been made (shot). Therefore, the controlled action production operation is a process of "manufacturing" these required film components to satisfy the predetermined specifications.

The editing functions and objectives in this type of production are to select and assemble the most desirable of these specifically prepared film parts. Within the limitations of these parts, the editor plans the technical means to physically combine them into the most effective presentation possible. Since the planned purpose and order of assembly of each scene are specified, the difference in this type of editing lies in the individual editor's artistic sensitivity and dramatic perception in recognizing, interpreting, and achieving the originally intended psychological effect of the film upon the audience. Very subtle factors are involved in making such abstract editing judgments. The editor determines which one of several almost identical shots is best, how much of it to use, precisely at which frame to join it to the next scene, and how to best employ any accompanying sound. Even though the controlled action editor is rigidly limited to using prescribed film parts, the way that he does it greatly influences the effectiveness of the final production.

SEMICONTROLLED ACTION.—Semicontrolled action applies to filming situations in which a reasonably predictable course of events, or some known documentary conclusion, can be expected to take place. However, such events are not subject to the type of intimate directorial control for filming purposes that is found in controlled action production. A traditional religious, military, or political ceremony; a technical demonstration, tactical exercise, or missile launch; a VIP reception or a formal review, all tend to follow some previously established pattern. You know where and when the event will occur, who and what will be the program.

Obviously, you cannot exercise the degree of precise production control required to deliberately "manufacture" specified film parts as you do in controlled action. But you can anticipate many desirable parts that will become available for filming as automatic byproducts of the nature of the situation itself. Therefore, a shooting outline serves much the same purpose as a formal script in identifying many of the parts needed to assemble a semicontrolled action film.

The editing functions and objectives in this type of production are to select and assemble a coherent representation of the actual event from the film coverage available. The end product in any semicontrolled production should be a film that captures the mood, realism, and significance of the original situation. Ideally, the film may even seek to heighten, sharpen, and emphasize these factors to some point beyond the real-life condition to assure maximum effectiveness.

The key to editing semicontrolled action lies in the phrase *film coverage available*. Anything that was not filmed simply does not exist and must be excluded from further consideration. Whatever was filmed may form the entire basis of the final presentation. The film itself dictates how it must be edited. Your ability to *perceive*, *image*, and *innovate* ways of arranging this footage to show an intelligible story will influence the effectiveness of the film. You must be aware of the meaning of each shot available and its relationship to the total original situation; otherwise you cannot assemble a meaningful film. At several earlier points in this training series we discussed slates, caption sheets, and general maintenance of accurate camera footage records. This is again particularly emphasized in relation to semicontrolled and uncontrolled filming. Shots that cannot be found, identified, or interpreted must be subtracted from the effective total of the film coverage available, and cease to exist for editing purposes. Some of the most sensational camera footage ever filmed has ended up in the trash because there was no record to tell the editor where it fitted into the other available coverage.

UNCONTROLLED ACTION.—Uncontrolled action applies to filming situations in which it is impossible either to predict or to control the course of subject action. News, sports,

category. The basic character of uncontrolled action coverage is invariably reportorial; that is, it seeks to present an authentic view of a situation or condition in essentially self-explanatory terms.

The editing functions and objectives in this type of production are to *preserve*, *clarify*, and *emphasize* the reportorial aspect of the coverage available. As in semicontrolled action, the film itself dictates its own editing and limits the creative scope of the editor entirely to the story elements that it actually contains. The determining factor of final effectiveness in this type of film is your ability to *accurately assess the significance* of the story elements available within the coverage and to assemble them in such a way that they become self-explanatory to the viewers.

The keyword questions of *Who*, *What*, *When*, *Where*, *Why*, and *How* form the basic framework that both the cameraman and the editor must constantly bear in mind in any uncontrolled action situation. Ideally, these questions are answered somewhere within the coverage available and are preserved and made entirely clear to the audience in the final edited film. The standard for evaluating an uncontrolled action production is that it diminishes in usefulness in direct proportion to the reportorial elements that are missing or unclear in the final film.

More than in any other type of production, the cameraman must bear the prime responsibility for good or bad uncontrolled action films. The editor has many options, methods, and filmic devices available to improve controlled action or to fix flawed semicontrolled coverage. However, in uncontrolled films there is little that anyone can do to create a meaningful production if solid, substantive reporting is not contained in the original coverage.

**Editable Footage**

The cameraman's comprehension of editing requirements as shown by the editability of the film that he shoots is a basic editing factor. Any experienced film editor can accurately estimate the degree of professional sophistication a cameraman has achieved merely by viewing his coverage from the standpoint of the ease with which it can be edited—its editability. If there is no bridging footage provided with which to connect major shots and shot sequences, the cameraman is

of transition shots, cut-ins, cutaways, reaction shots, and background material is in the coverage, the editor knows that he is working with a "pro." Thus, it will be possible to put a meaningful motion picture together instead of merely "faking" a film by assembling a selection of random shots.

In theory, editability is built into every shot specified in a controlled action production. In all other types of production, an editability factor must be injected into the coverage by the way the cameraman chooses to shoot his assignment. In all semicontrolled and uncontrolled filming, this critical aspect of editing begins at the camera, not when the editor is handed the film. Essentially, this kind of editability involves preparation by the cameraman in filming adequate *protection footage* and in applying the principles of *editing in the camera*.

PROTECTION FOOTAGE.—This is a "generic" term for scenes that do not contain the factual coverage, but which relate closely enough to it to be used for bridging continuity between factual scenes. A protection shot of a sporting event could be an official signaling a score or penalty, the scoreboard, the goals, a spectator's reactions and expressions, and closeup action of the contestants' hands and feet. Filming a military ceremony, "protection" might be shots of the reviewing stand, people exchanging salutes, the color guard passing, massed troops, the band, and marching feet. Such shots can be made to serve transitional purposes—connecting adjoining factual coverage scenes. Any assignment offers subject-related people, places, and things. These should always be filmed to give the editor an "escape route" when he is trapped between factual coverage scenes which cannot be made to join together with good continuity. This is not to suggest wasting film, since most protection footage will never be used. The realistic rationale is that using a small percentage of the total film expended on a project to literally guarantee that the coverage can later be edited is sensible, "low-cost insurance."

The logic of shooting protection footage is evident in filming semicontrolled and uncontrolled action. Yet, even in controlled action production, despite the fact that the equivalent of protection footage is included in the script requirements,

a script is only an *imaginary* visualization of a filming environment, not the real-life, on-site situation. There may be opportunities to shoot protection footage during the filming of a controlled action project that were never contemplated by the scriptwriter when he wrote the script. Every camera setup should be deliberately evaluated with this thought in mind. Possibly there is a better shot or, as is often the case, the scripted shot won't work as intended, and such a situation could later cause major editing problems. The only safe rule is that protection footage must be made from what is *really there* when the film is *really shot*—look for it and shoot it *then*. There are few experiences more demoralizing to an editor than to discover midway through editing a film that he has absolutely no available coverage to bridge into the next scene. This experience is even worse if the editor is the same person who shot the film—you, for example.

EDITING IN THE CAMERA.—In controlled action filming, the script instructions to the cameraman describing how each scene is to be filmed are designed to result in specifically editable footage. The precise camera angle and details of any camera movement are stated. The desired coverage of the performer's actions and movements are outlined. Whether the scene is to be filmed as an ELS, LS, MS, CU, or ECU is specified. The purpose of all of this information is to ensure that the individual shots will fit together in a planned order and relationship when they are assembled into a total film. It can be said that footage made in this way is pre-edited by the manner in which it was originally filmed. This is editing (or cutting) in the camera in its purest form. The cameraman knows in advance how each shot should be filmed so that it will edit in acceptable continuity with the shots which precede and follow it in the completed production. This type of meticulous shot preplanning and production control is impossible in typical general coverage and documentation assignments. However, the basic concept of deliberately filming individual shots in such a way that they are specifically editable with others is a professional practice in any form of filmmaking. To successfully accomplish this form of editing in the camera, the cameraman must understand the each shot as it is filmed.

Cameramen who understand editing requirements have an approximate shot order and sequence relationship in mind as they film—mentally scripting the equivalent of an edited film as they go about their job of covering an assignment. Often, this is a matter of conditioning by the experience of having filmed so many other similar projects that they automatically sense essential filming requirements. As a basic example, they will recognize that an overall long shot is needed to establish a significant locale, and that a detailed, extreme closeup is also needed to reveal some physically small but vital visual fact about the subject. After shooting these "key scenes," they then deliberately film intermediate coverage which is specifically designed to provide bridging continuity from the establishing LS to the detailed ECU. In effect, they *film whole related shot sequences* rather than individual shots. Hence, the editor need only put these shots in proper sequence and trim out excess footage to complete entire units of the total film. Such knowledgeable cameramen continuously look for natural transition shots and regularly select multiple camera angles and image size changes to provide great editing flexibility in assembling interesting and intelligible shot progressions. Some are even sharp enough to be aware of and to remember specific "holes" in their factual coverage which could not be avoided under actual semicontrolled or uncontrolled filming conditions. And they film specific "patches" to fill in the missing coverage.

These aspects of editing in the camera are helpful to you as an editor and often contribute to making better films, but there also are potentially damaging factors that must be noted and guarded against.

You must fully understand the cameraman's intended assembly plan for any camera-edited footage. In turn, this requires complete camera records that clearly indicate the sequential relationship of each shot. If they are not identified, you cannot be expected to instinctively recognize all parts of a preplanned sequence. Thus, you may blindly attempt to resequence some critical footage with the result that the coverage becomes literally uneditable; and the entire project is ruined.

Camera-edited footage should never be shot so "tight" that no alternative coverage is

difficulties, physical damage to the film, and any number of other causes. There is no guarantee that every foot filmed will later be available to edit. In fact, it is rare that the editing of any coverage is ever possible exactly as planned. Even controlled action is usually revised in some way during the editing process. Therefore, if every shot made is required to edit an intelligible film but some of these shots are destroyed, the remaining coverage may be rendered uneditable. Some hedge against this eventuality must be built into the filming of any assignment.

An attitude on the part of a cameraman that he can successfully "remotely control" an editor by editing in the camera must be eliminated because it is both arrogant and foolish. Film editing is an advanced technical and artistic skill in its own right. It serves to improve, rather than to detract from the cameraman's product. No matter how "good" a cameraman may really be, or may erroneously imagine that he is, his action to deliberately shoot film that forces an inflexible editing plan upon an editor is self-defeating. By the nature of his function, the editor exercises far more positive control over the final character of a film than camera editing alone could possibly achieve. A cameraman best serves his own interest by providing coverage which invites an editor to function creatively, rather than to intentionally shoot footage designed to fight an editor into submission.

**Maintaining Visual Continuity**

*Showing* a story is precisely the same as *telling* a story, except that the language used to convey information is based upon effectively using pictures rather than words. As in any other kind of storytelling, visual communication must contain an identifiable starting point, lead its audience through the systematic presentation of a coherent message, and end at a logical point of conclusion. This orderly structuring of the facts, ideas, and abstract suggestions required to form a meaningful film is called sustaining or maintaining continuity.

In module 2 of this training series, we discussed maintaining continuity in the context of camera handling and filming techniques. Several separate areas of procedures and techniques for maintaining continuity were

degrees. This is no coincidence, but rather evident, that considerations relative to continuity permeate all aspects of filmmaking. You begin by shooting coverage to contain the basic elements of continuity. In turn, this coverage provides the essential raw material for editing. Therefore, editing can be described as the process of *extracting and refining continuity* from the available film coverage. If there is not much of it in the coverage, the continuity yield of the final edited production will be disappointing; and so will the communicative value of the entire presentation. If the coverage is filmed with careful regard to sustaining continuity, the editing process will be simplified; the final presentation will be proportionately increased in its communicative value.

Over the years certain "filmic devices" have been created to cause viewers to attach specific meanings to certain types of film progressions. For example, when an actor looks out a window, you expect the next scene to be what he sees. Therefore, even though the images are totally unrelated, continuity is sustained by a preconditioned transfer of ideas. Similarly, the "flashback" or "flashforward" to some unrelated location or time is accepted, as is the "cut-in" to a CU of an object after an actor "telegraphs" that it is coming by pointing, gesturing, or looking.

To tell a story in speech or writing, you must think in terms of choosing words and forming sentences; then combining sentences into paragraphs and paragraphs into chapters until the entire story has been structured into a coherent message. To show a story by editing film, you must also form a structure. Pictures that indicate the ideas, feelings, facts, and information you wish to communicate must be selected. These are then combined to signify complete thoughts, sequenced into groups of thoughts, and so on, until an intelligible communication has been assembled.

Individual shots might equate to single words in some cases, or to whole sentences and paragraphs in others. A given shot progression might be the equivalent of one or more written pages, and a complete shot sequence could represent chapters. A series of sequences constitutes the whole film, just as a sequence of chapters comprises a book. The smallest film

element is the individual shot, and like individual words, shots can have changing meanings. As an editor, in each shot you select you must find the exact point at which the shot means whatever fact or idea you want to express. You must then find and add other shots to express additional meanings required to further develop the story.

The purpose of developing the shot sequence is to form "modules" of the story, which can then be connected to other completed sequences to build the continuity which will show the whole story. A complete shot sequence could be as brief as a single play in a football game, beginning with the huddle and ending with the downing of the ballcarrier—a matter of only 3 to 5 seconds. Other shot sequences could comprise an entire production. A dramatic/documentary film detailing step-by-step preparation for a mass prisoner of war escape during WWII could actually be a single, 2 1/2-hour long, shot sequence. Since there is no other theme in the film than the preparations for escape, and no deviation from that theme is present in any part of the continuity, every one of the several hundred shots in the film can be considered to be a part of one continuous shot sequence.

Typically, the individual film elements which will comprise a normal shot sequence are the basic shot progressions (LS to MS to CU), secondary shots (cut-ins, cutaways, transitions), edited overlapping action, and possibly special effects. In special circumstances, additional elements, such as animation, time-lapse and high-speed photography, titles and graphic materials, may also occur within shot sequences. Normal practice, however, is to treat such specialized film parts as shot sequences in and of themselves.

We have seen that the basic purpose of a motion picture is to serve as a vehicle to convey coherent visual communication; that the essence of accomplishing coherent communication lies in maintaining continuity; and that success in maintaining continuity is derived from the effective structuring of shot sequences. Moreover, the attainment of all of these characteristics in a finished film is most directly the responsibility of the person who edited it.

**Editing Planning**

As a film editor, you must have a "split personality." Half of your abilities will have to do with the imaginative/creative aspects of visualizing how various bits and pieces of film can be made to fit together to form a meaningful message. The other half of your skills concern performing very precise manual/mechanical functions in handling, keeping track of, assembling, and combining many film parts to form a finished motion picture. Your work combines abstract planning and tangible physical/technical functions.

The only common denominator is that both areas of responsibility involve a refining process—systematically reducing and condensing sheer film mass, so that its essence may be identified, concentrated, and used, and its undesirable byproduct eliminated. When starting out to edit any film you will be confronted by many times as much total footage in the raw coverage as the final production will contain. This ratio varies widely, depending upon the type of project and many other factors. As an example, the original coverage-to-edited-footage ratio in formal, controlled action films may be 10 to 1 or more; that is, over 2 miles of coverage must be refined to one-tenth of its original volume to end up with a half-hour, 16mm film. This condensing/eliminating process begins with preliminary editing planning and is sustained until the final splice is made in the printing master.

Your first step in the editing process is to decide, in general terms, what it is that you intend to say—what is to be the basic theme of the story which you are preparing. In controlled action production, this decision has already been made; and you are informed of this by the script. In semicontrolled and uncontrolled action projects, this decision is substantially influenced by the actual content of the available coverage. In all cases it is essential for you to know what you have to work with at the outset, since this must form the basis for planning all subsequent editing actions.

Your first references are the caption or data sheets, scene or shot breakdown sheets, cameraman's notes, and all other written data that are supplied with the coverage footage. This provides an insight into the nature of the subject and the extent of coverage. If the cameraman is available, the coverage, in general, and any camera-edited sequences in particular should be discussed and appropriate written notes made for later reference. If you are the cameraman, or personally involved in the filming, this "paper screening" should still be conducted to refresh

your memory and to focus attention on known coverage problems and probable outstanding footage. There is always an impatience to get on with looking at the film, particularly if you are directly involved in the actual filming. A review of the records first, however, tends to precondition your perception to a greater awareness when you see the film. Thus, the actual viewing of coverage is made substantially more productive. The initial paper screening can only provide a general familiarization with the project. The second part of editing planning is viewing the footage.

**CAUTION**

Camera original film should not normally be viewed. If under extreme circumstances it becomes necessary to view the camera original film, you MUST take every possible precaution to protect it from physical damage, finger marks, dust, dirt, oil splatters, and rewind "cinching." Any physical handling should be done ONLY while wearing clean, cotton editor's gloves. Rolls of film should be replaced in cans immediately after use.

If the original camera film has been duplicated to a workprint for viewing purposes, film damage concerns are far less critical, but you should make a reasonable effort to keep the workprint clean and in as good a physical condition as possible. This film will be subjected to extensive handling in the editing process. The longer it can be kept relatively undamaged, the less annoyance and delay will be encountered in working with it later.

Actual viewing may be accomplished by using a regular projector or a motion viewer. If double-system sound is involved, you must use an interlock projector (a special type of projector having provision to project separate picture rolls in synchronization with separate sound tracks), a film-editing system type of editing machine, or a motion viewer mechanically synchronized with a sound reader. In all cases involving double-system, you must view both the picture and listen to the sound together in synchronization for a meaningful evaluation to be possible. A flaw in either picture or sound must be observable at the same time.

Whatever picture and/or sound reproducing equipment is used for viewing the coverage, it must be free of film damaging characteristics. All equipment must be carefully cleaned, inspected for residue buildups or burrs in the film-flow paths, and tested for scratching or sprocket hole damage with a strip of fresh film before running the coverage. This equipment cleaning, inspection, and testing process should be repeated at intervals of about every 1000 feet of film during the viewing session because there is no way to anticipate the rate of buildup of emulsion flakes and other deposits that might damage the film. "Green" film (film fresh from processing which has never been run before) is far more susceptible to surface scratching and causing equipment malfunctions than "cured" film which is lower in moisture content—hence, harder and less sticky on the surface. The film which you will be viewing in the initial coverage run-through is generally green, and potential damage hazards tend to be greatest at that time.

This initial viewing of the "raw," uncut, bulk coverage is sometimes referred to as the planning scan. It serves several essential functions:

- Provides the opportunity to compare the actual film with the filming records to cross-check accuracy; or permits making any additions, corrections, or deletions in the records to reflect the actual content of the coverage.

- Shows the editor what he has to work with—the scope and quality of the overall coverage, and identifies both the unusable and the outstanding scenes for special consideration.

- Dictates the editing theme of the final film in semicontrolled and uncontrolled action projects, or verifies that all shots called for in a controlled action script are contained within the coverage and are of usable quality.

- Gives the editor a general overview of the subject in terms of the specific shots which are available and usable. This is necessary to tentatively plan individual shot sequences as well as the overall arrangement of sequences that will be required to make up the final film.

- Begins the scene-logging and bulk roll breaking-down procedures necessary to eliminate unusable, duplicate, and excessive footage as well

related to them. However, we should mention several things about properly conducting this initial viewing of available coverage:

- If a workprint is available for the scan, it should be viewed on a projector, rather than some form of motion viewer, despite a greater hazard of film damage. The projector image will normally be larger, steadier, and brighter than a motion viewer image. Since a major purpose of the scan is to evaluate the *quality* of the available coverage, the better the images can be seen, the more accurately you can evaluate their quality. How sharply focused are the shots? How steady are the camera movements? How precisely are the shots composed and framed? What are the exact facial expressions of the performers? Such detailed image quality factors may be perceived incorrectly or not at all if the viewing image size is too small, shaky, and dimly illuminated, as is often characteristic of motion viewers.

- Evaluating the quality of sound contained in the coverage is also an important purpose of the scan. If a sound reproduction source is used which introduces sound distortions, it is impossible to make accurate sound quality judgments. The sound playback equipment used for the scan must be capable of providing sound quality which is at least equivalent to that of an average projector.

- Proceeding slowly and methodically. Spend as much time on the scan as it takes to be thorough. The whole idea of the initial, total coverage run-through is to accomplish a series of necessary actions at one time. Any of these that are not fully done during the first viewing will require another viewing, thus exposing the footage to further damage hazards and taking up more time. *There really are no shortcuts in editing film except, perhaps, skills developed from experience.* Time and effort, which may appear to have been saved at one point, will inevitably have to be spent at some other point in the editing process. Avoid impatience—it is not compatible with editing.

THE SHOT LOG.—If you conducted the planning scan properly you will have an accurate record of the actual content of the coverage and context, special characteristics include identifying shots made as a part of a camera-edited progression, shots containing overlapping action, cut-ins, cutaways, and transitions. Unusable and unusually excellent footage will have been noted as to location within the bulk rolls, subject matter, and approximate length.

The information that these listings contain is combined to form a tabulation showing the shot contents in order within each bulk roll of the total coverage, together with notations of the subject, shot progression quality, and length of each shot in the total coverage. This is the *shot log*. It may actually be a corrected and annotated copy of the original data sheets, or a separate, new listing prepared from the scan results.

The shot log serves as your basic reference as to what you have to work with. From it, you can decide what the editing must be in the case of semicontrolled and uncontrolled projects. For example, you may find that you have many excellent action shots, some spectacular close-ups suitable for dramatic cut-ins, and a few nonspecific transitions. You may also find that there is very little usable introductory, orientation, and general bridging material contained within the coverage. You can't build a start-to-finish type of story because you don't have the necessary kind of visual continuity footage available. However, there is no question that you can assemble an exciting highlights show from the type of shots that you do have. In the opposite circumstances of limited dramatic footage, but with a good selection of general supporting and bridging shots, you might elect the start-to-finish theme.

In controlled action production, the shot log serves as a checklist of the shots specified in the script, either verifying that all shots called for are present within the coverage, or identifying those that are missing.

The automatic byproduct of reviewing the shot log to determine the editing theme is that possible sequences become apparent. You become aware of potential relationships between various individual shots and shot progressions, such as: "*This overall establishing shot of the base, together with that one of a staff car approaching base headquarters, could be combined with the camera-edited shot progression from outside*

*headquarters, to inside—to the admiral's office; to form a complete opening for the film.*" Thus, a tentative shot sequence has been perceived and, as the log is studied to find other shots illustrating the selected theme, other potential shot sequences will be recognized. Even if actual groupings of specific shots are not immediately apparent, categories of coverage are. These, in turn, dictate the shot sequences which must be developed to form the film. For example, there are several shots of crews at a preflight briefing, several shots dealing with aircraft preflight on the line, crews arriving at their aircraft, startup, taxi, and takeoff. We know from the available coverage that a briefing, aircraft preparation, crew preparation for departure, and departure sequence will constitute the finished film. Therefore, the search for individual shots is narrowed to these categories to assemble each sequence.

Developing the Editing Treatment.—The intended theme of the film, together with apparent shot sequence categories, or the individual shots of a sequence, if one has been tentatively identified, should be listed so that what you are trying to do and how you intend to do it is entirely clear to you and you will not become confused by the distractions of actual editing. This statement of the film's purpose, together with the proposed, tentative order of shot sequences outlining the visual progression of the total presentation, actually becomes an informal script. This plan of editing objectives and method of accomplishment is called the "editing treatment." Sometimes, it exists only in the editor's mind, if he is a thoroughly experienced professional working on a relatively short film. For a beginner, the treatment should take the form of a written memo so it can be used much like a script, to check off requirements as they are satisfied, and to keep track of work left to be done.

**Film Cutting**

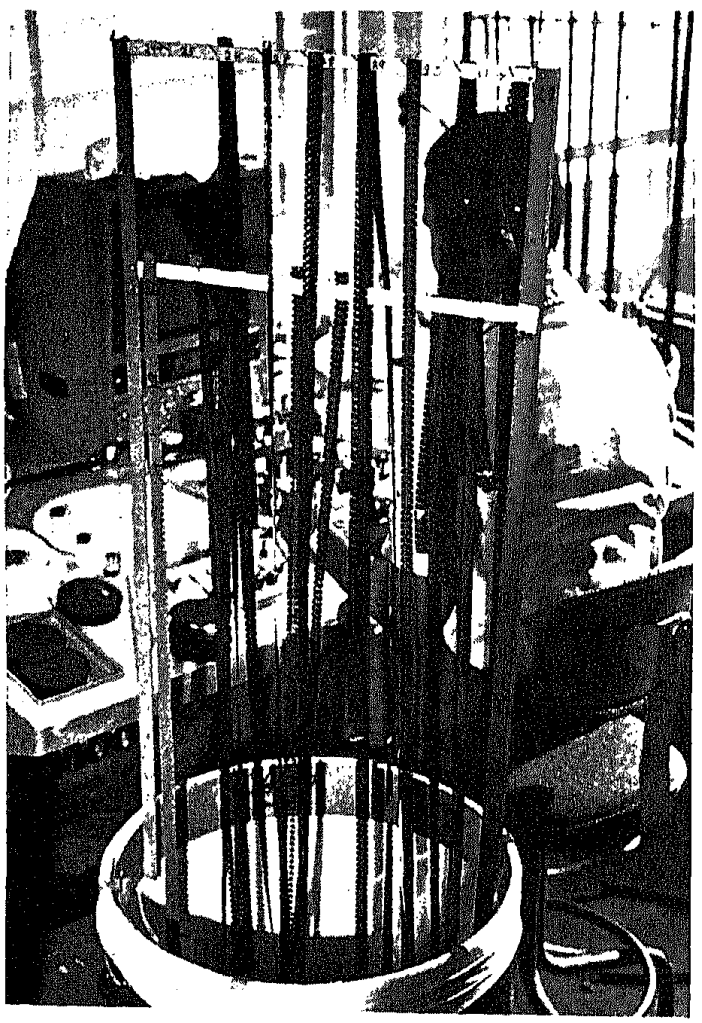
The original camera exposed film is sent to the laboratory for processing. After processing the film, the lab makes workprints or copies for cutting. These first prints are called *dailies* or *rushes*. The camera original film is *not* cut until the final form of the film has been determined and the workprints are edited the way the final print is to be presented to the audience. Once you have a smooth workprint, you cut and match the camera original to it. Copies of the matched original are then made for distribution. If the original camera film were cut before a smooth workprint was made, the original film, and its copies, would show the dirt, scratches, and joints caused by the repeated handling required in film editing.

In the course of cutting and editing the workprint, you will need to experiment with the shape, form, and sequencing. You may try one scene in one position then in another position or sequence or you may try to shorten one scene and find it needs to be longer or even shorter for the sake of tempo and/or continuity. If you are working with a workprint, alterations won't be any problem. You can cut and splice the workprint as often as you like. If something isn't right, you can always get another copy from the original and rework the new workprint or any part of it. However, if you were working with the camera original film and something went wrong, every defect in it would be reproduced in every release print made from it.

BREAKING DOWN THE WORKPRINT.—The physical process of sorting the shots within the workprint bulk rolls into shot sequence related categories and extracting outstanding footage, while eliminating unusable footage, is called *breaking-down*. Just about every editor has his own method of doing this. Some go through the coverage eliminating only bad footage first, then collate shots by general categories, one group at a time. Others break everything down in a single operation, collating all shot sequence categories simultaneously, while eliminating unusable footage as they come to it. The method is unimportant as long as the overall objective of reducing the film mass and individual shots into some cohesive use groupings is accomplished. Ideally, the use groupings selected will correspond to the order of shot sequences which were planned to structure the film. Often, this is not possible, since such a structure may not yet have been determined. In such cases, broad situation-type categories are substituted for breakdown purposes, such as *before the ceremony*, *during the ceremony*, and *after the ceremony*, with additional subcategories—sound coverage, silent coverage, interiors, and exteriors. If no better option presents itself, it may finally work out that these arbitrarily selected breakdown groupings will form the basis of the order of sequences finally used to structure the film. Normally, the individual shots of a category are taped together and wound on a single roll until

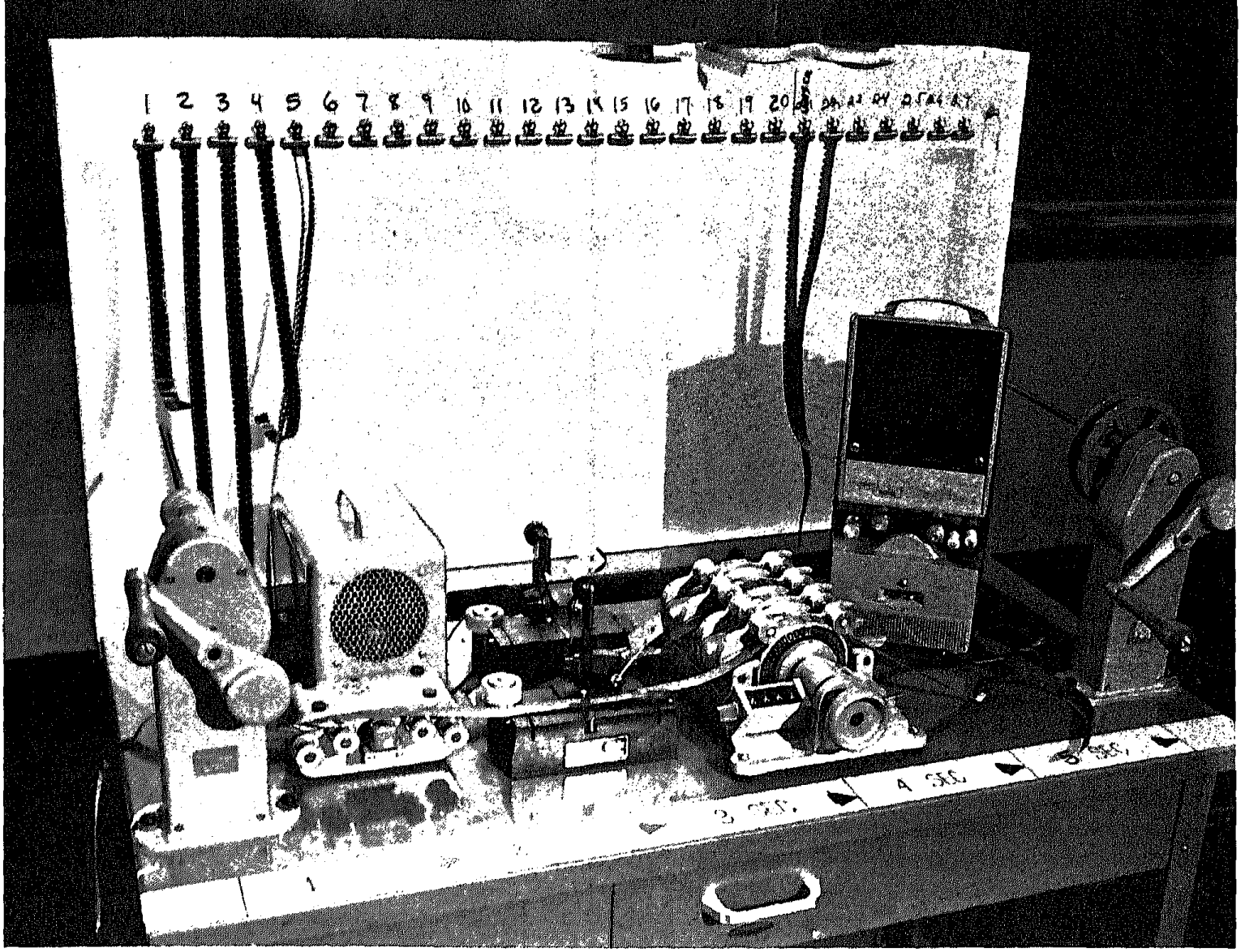
all shots of that category have been collected. Then another roll is begun for the next category until the whole coverage has been broken down.

In major production situations, a listing much like the shot log is prepared as the breakdown progresses. This describes the shot, gives its edge number identification, and relative location within the breakdown roll. This is called a *scene log* to distinguish it from the shot log, but it is used basically the same way; i.e., to plan the editing of a particular category of shots just as the shot log was used to plan editing for the whole coverage. After the breakdown roll has been collected, you begin to form one or more shot sequences from the individual shots that the reel contains. This entails hanging the individual shots up so they may be viewed separately and selected in any order desired. Shots are hung by several methods—the most common being either an editing barrel or an illuminated viewing panel. The "editing" barrel is a deep container with a rack extending above the barrel that contains many pins for suspending pieces of film by their sprocket holes. The barrel is lined with a removable, clean, cloth bag to prevent soiling the hung shots. Film is unhooked from the pins, viewed, and rehung in the tentative order of assembly decided upon. The viewing panel is an illuminated strip of translucent glass or plastic with many pins for hanging film above it. Below the panel is a hopper-type box to contain the film. As in the editing barrel, this hopper is lined to prevent soiling and damage to the film. Since the shots are suspended from a point above the illuminated panel, and pass in front of it as they descend into the hopper, the images can be seen in their hung position. This permits you to view, select, rearrange, and rehang the shots into a tentative order of assembly.



You can make your *first* assembly of the film on a simple film-editing table equipped with two film rewinders, a viewer, and a tape splicer.

1. Place an empty film reel on the right-hand rewind and wind some leader onto the reel.
2. Attach your first scene or shot to the leader. All the scenes, cuts, and shots should be in script sequential order in one or more film barrels or bins. The *main* objective of your first assembly is to get all the scenes in script order—NOT to cut (edit) them to length for proper effect. Using a tape splicer, join the head of the first scene or shot to the tail of the leader. Start winding the leader, with the first scene attached, onto the takeup reel.
3. When you reach the end of the first shot, tape splice the head of the second scene to the tail of the first.
4. Continue this process until the film bins are empty and you have a complete roll or rolls of assembled shots.
5. The first assembly should now be viewed with a projector to ensure that the scenes have been placed in their proper order and to get a better check of the film's quality.
6. Next, using a motion viewer to study the film, decide where to cut the scenes to their appropriate scene length and match the action between various scenes. Use a grease pencil to mark the cut point on the film. Always make your cut mark on the base side of the film and DON'T mark on the frame that is to be left as part of the shot. As each scene is cut, timed, and matched, it is again spliced, with tape, to preceding and subsequent scenes.
7. Again, project the film, taking notes for further editing. The only accurate way to



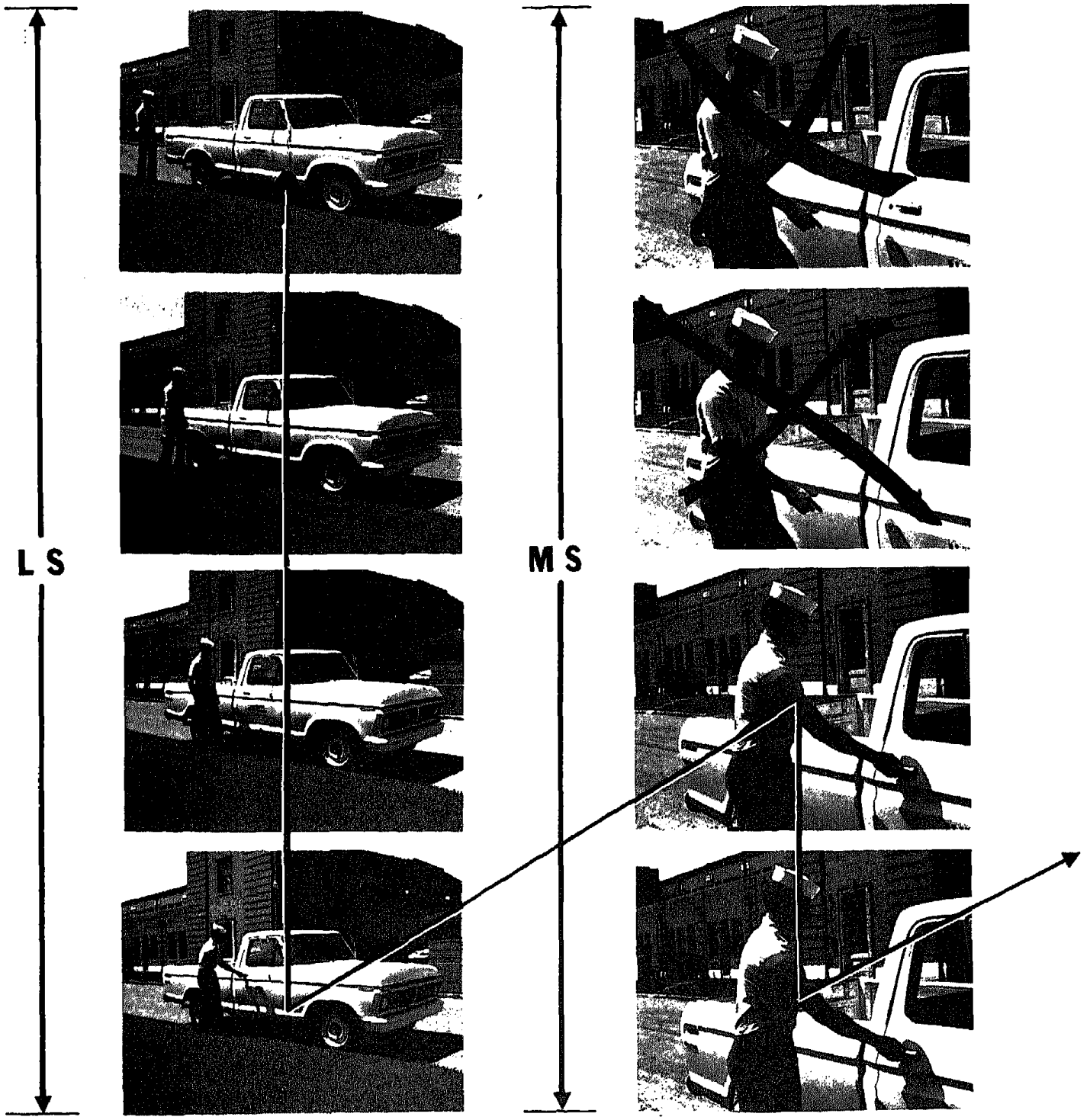
determine correct scene length is by projecting and viewing the film over and over, cutting and splicing, cutting and splicing, until you have it right.

Gaps in the action can be covered or long scenes shortened as required by means of insert shots such as cut-ins, cutaways, etc.

WHEN TO CUT.—Editing, as we have said, is largely a matter of experimentation. There are no rules engraved in stone which you must follow. However, just as in shooting mopics, there are certain established principles of editing which will help you put together a coherent and effective film. The two most important are cutting for continuity and cutting for visual impact.

Motion picture films are not always cut or edited for the visuals. The sound may be more important than the picture—especially with music or dialogue. And, other times the best cutting point for the visual and audio may conflict. However, in general, the visual is of primary importance. You will usually find that *powerful* visuals tend to have more effect than *crucial* dialogue. Therefore, the action should usually be considered first.

After you have all the scenes in proper sequence, and when viewing your first assembly, the first thing to ask yourself is whether a cut is needed at all. Even though the action may have been filmed from different angles and you have many bridging shots available, you must decide if they will add to or take away from the main action. Does the primary shot stand on its own? Are the angles and content of the other bridging shots, such as cutaways and cut-ins, sufficiently different from the primary shot to enhance the scene, or will they merely complicate the scene and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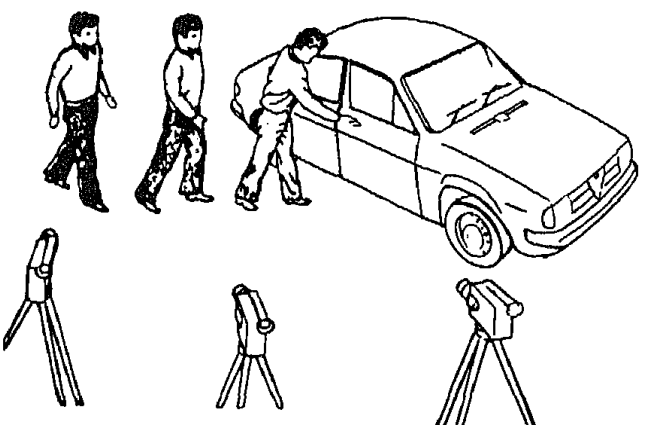
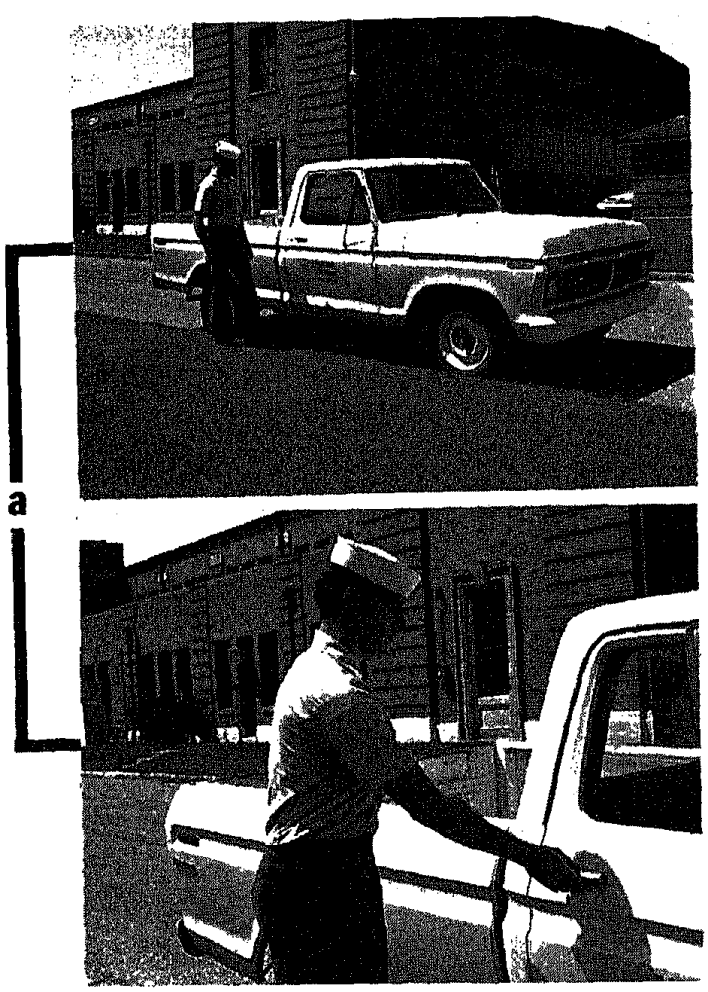


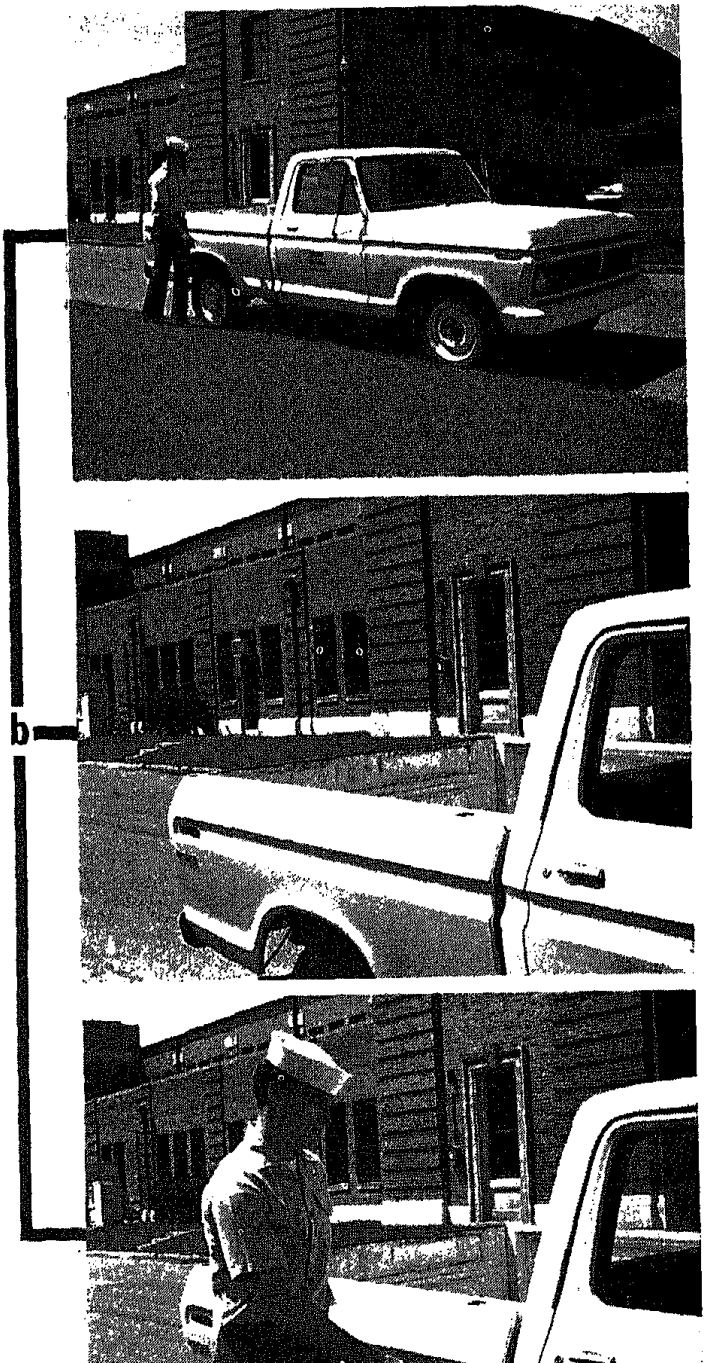
CU
EDITED

action without strengthening it? Don't make a cut just for the sake of making a cut, or just because you have some matching footage shot from a different angle.

WHERE TO CUT.—Suppose the cameraman has filmed a sailor walking up to a truck door, opening it, and getting in. He has shot the scene from three different angles to give you maximum editing flexibility. Your editing plan is to cut from the LS to the MS as the sailor gets to the truck, and to the CU as he reaches for the door handle, as shown on pages 1-70 and 1-71. Now, consider these points:

● *Continuity*—When you select a cutting point for the transition between the LS and MS, you must maintain continuity. In other words, the sailor must have his legs, arms, hands, and body in the same relative position in both shots. The action at the cut point of the LS must match the action at the beginning of the MS so that both shots flow together smoothly. Don't cut the film in such a way that you produce a *jump cut* or *double action*.

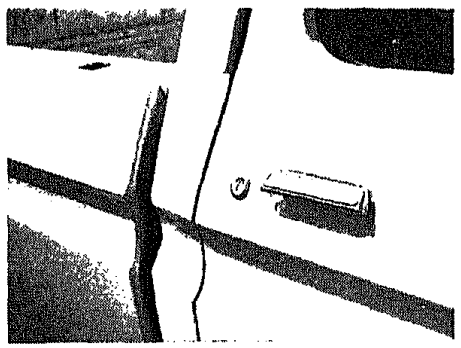


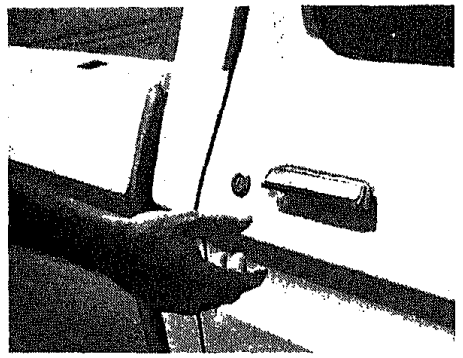




**(a) Jump cut; Cutting from this LS to this MS will produce a "jump cut." The sailors arm will appear to "jump" from his side to the door.**
**(b) Double action; Cutting from this LS to the MS of the**

If the cut you make deletes part of the action, this creates a jump cut. It may be a slight mismatch in which case the action "skips," or it may be a large mismatch in which case the action suddenly "jumps" from one position to another. If your cut repeats part of the action, it is known as double action.

● *Visual Action*—As a general rule of thumb, an action cut should be made a fraction after the beginning of a movement. For example, when cutting from the MS to the CU of the sailor opening the truck door, cut at the point just as he makes the first suggestion of a move toward the door handle—i.e., just as he begins to extend his arm. In this way, the cut is visibly motivated and the action will carry the viewer's eye smoothly over any gaps or flaws in the continuity. If instead, you make the cut halfway through the action (e.g., *just after* the sailor's hand reaches the door handle), the cut will tend to be "relaxed."



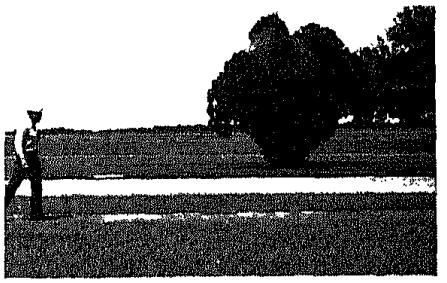


Of course, there are other ways this scene could be edited. For example, if you wanted to compress the scene, you could cut directly from the LS to the CU, showing the door handle alone in the frame for a second or so before the sailor's hand comes into the scene.

SHOT LENGTH.—Thus far in our discussion, we have talked only about cutting between shots of the same scene. However, not all editing is concerned with intercutting different camera angles of the same scene or event. Often you will be cutting together shots from different times, places, or scenes. Each single shot will have its own pace or rhythm, and probably a continuous series of action through its length. Your job, therefore, is to locate a good "in-point" as well as a good "out-point" within each shot.

Within a given shot there are probably several good in- and out-points. To decide which in- or out-point to use, run the film through a motion viewer several times and look for positive action; e.g., the sweeping gesture of a hand or the exit of an actor, etc., from the edge of the frame, that will lead the viewer's eye into the next shot or out of an old one.

IN-POINT
START SHOT AS SAILOR ENTERS FRAME



MID-SCENE

OUT-POINT
END SHOT AS SAILOR LEAVES FRAME

The point of positive action is not the only criteria for the length of a shot. More important is the length of time the shot can be "held" on the screen. That is, how long the shot can hold the audience's attention. This depends on several things among which are the nature and complexity of the subject and the overall rhythm of the sequence. Viewing the film on a motion viewer is not the best way to judge the scene length. The best thing to do, therefore, is to cut the shot long at first, then [illegible] sequence at the correct fps rate with a projector.

Keep in mind, the more information you include in a shot, the longer it will take the audience to understand it. However, if the shot has been seen before, it can be cut quite short, but, there is always the danger that as you edit you may become overfamiliar with the footage, and cut the shots too short.

**Splicing motion picture films is not a complicated procedure, but a great deal of damage can be caused to film and to projection equipment by poorly made splices. A good splice can be made by either of two common methods: tape splicing, in which a transparent adhesive tape designed especially for the purpose (Kodak Presstapé, for example) is used; or cement splicing, in which the ends of the film to be spliced are overlapped and fused together.**

**Film cement is a chemical solution containing solvents that partially dissolve and then fuse together the film ends. Eastman Kodak Company, for example, manufactures two such cements:**

- **Kodak Film Cement, which is formulated primarily for splicing films on an acetate-propionate base.**
- **Kodak Professional Film Cement, which has a slightly different composition than Kodak Film Cement. Kodak Professional Film Cement is suitable for all films on a cellulose-triacetate base plus those on an acetate-propionate base. In other words, it can be used on almost all motion picture films.**

**There are many commercial cement splicers available today, ranging from simple models for the amateur to units designed specifically for specialized professional applications. Some splicers have built-in scrapers (necessary for preparation of the film to be spliced), often with adjustable guides to control the depth and width of the scrape. One type of splicer, the hot splicer, has a heating element under that portion of the splicer where the film cement is applied. This element reaches approximately 100 °F and the heat, by increasing the evaporation rate of the solvents in the film cement, decreases the drying time of the splice from 15 to 20 seconds for a conventional splicer to 8 or 10 seconds.**

**It is a good idea to practice making splices with scrap film; this is an inexpensive way to learn the "feel" of the splicer and to recognize the pressure necessary for proper scraping.**

## CAUTION

**Film cements and their fumes are mildly irritating, and they should be kept away from your eyes.**

**The solvents used in film cements are volatile and can burn rapidly. While modern film bases are not fire hazards, the film cements can be.**

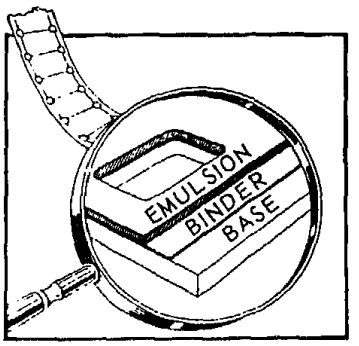
**Film cements can damage enamel and other finishes, and the man-made fibers in clothing.**

**Motion picture film is constructed of three layers:**

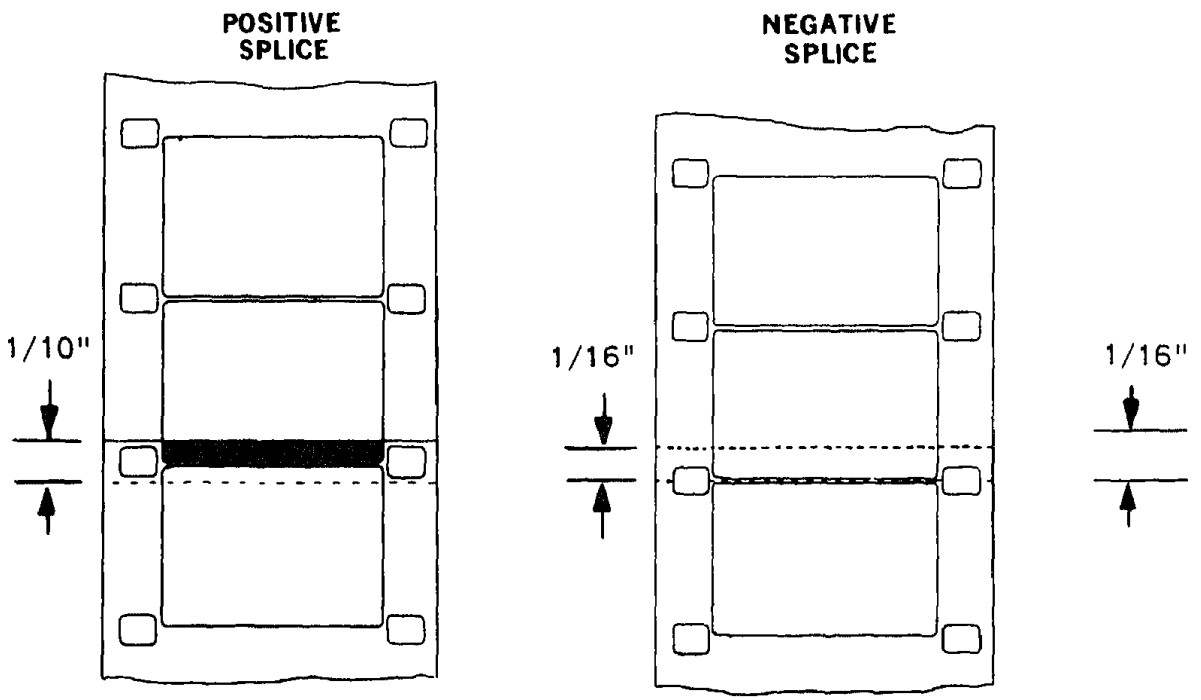
- **An *emulsion* coating, consisting chiefly of gelatin. In this layer is suspended the silver or dye that forms the photographic image.**

- **The *binder*, a thin layer between the base and the emulsion coating, binding these two layers tightly together.**

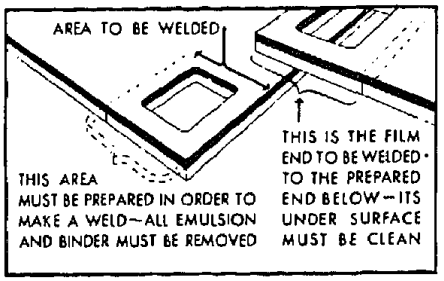
- **A flexible film *base* that provides a strong, durable support.**

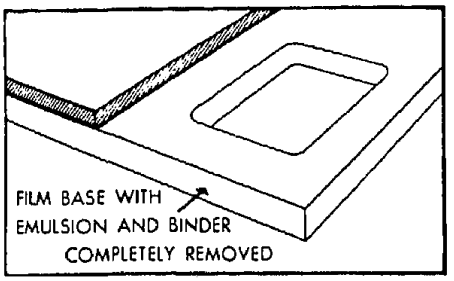



**The two splice widths most common in film editing and repair are the *positive* splice (1/10-inch overlap) and the *negative* splice (1/16-inch overlap). These names do not refer to positive or negative film, nor do the names imply a degree of splice reliability—both splices are reliable when made properly. The positive splice was developed first; unfortunately, it is quite visible when the film is projected. Therefore, positive splices are suitable for film that will not be used for printing (release prints, for example). The negative splice is narrower and overlaps a different portion of the projected picture; it is less visible but just as reliable.**



removed completely from the section of film that will be overlapped in the splicer. The base of the bottom film must be bare and ready for fusing into the base of the overlapping film. Be sure to take off the binder layer, which is hard but shinier than the base. After scraping, wipe the prepared area with a clean dry cloth or brush to remove all emulsion residue before applying cement.




The scraper on some splicers is equipped with guides that control the depth and width of the cut—on other splicers, however, the amount of pressure and the number of scrapes determine the depth. In any case, it is best to scrape the film with light strokes at first, then gradually increase the pressure until emulsion and binder are completely removed. If the pressure is too great, or uneven, the base may be torn, gouged, or just scraped too deeply. This produces a weak spot in the base, and a weak splice.

The base side, or undersurface, of the film that will be overlapping in the splicer may have oil on it, picked up in projection; also, some films are made with a thin coating on the back. If a good splice is to be obtained, any oil or base coating must be removed.

To remove oil and other coatings, wipe the back of the film with a dry cloth. Further rubbing with a cloth moistened with alcohol is often helpful. Many film editors prefer to apply a moderate amount of film cement to the base and then quickly wipe it completely off with a soft cloth. If these simple measures fail, lightly scrape the splice area of the base side. Be careful not to leave abrasive particles on the back of the film, since there is a possibility they will spread through the roll and scratch the film.

If the film is old, it may be necessary to treat the back surface of the film base with film cement before splicing. As film ages, it becomes dry and sometimes brittle. An application of film cement acts as a conditioning agent, to help prepare a good splice.

As mentioned previously, film cement is a chemical solution that dissolves film base. In addition to a solvent, it contains chemicals that stabilize its action. If film cement is exposed to the air, the solvent will evaporate, the cement will become thick and gummy, and usually it will not make a satisfactory splice. For these reasons your bulk supply of cement should be kept in the original container, and a quantity sufficient for immediate use transferred to a well-stoppered working bottle.

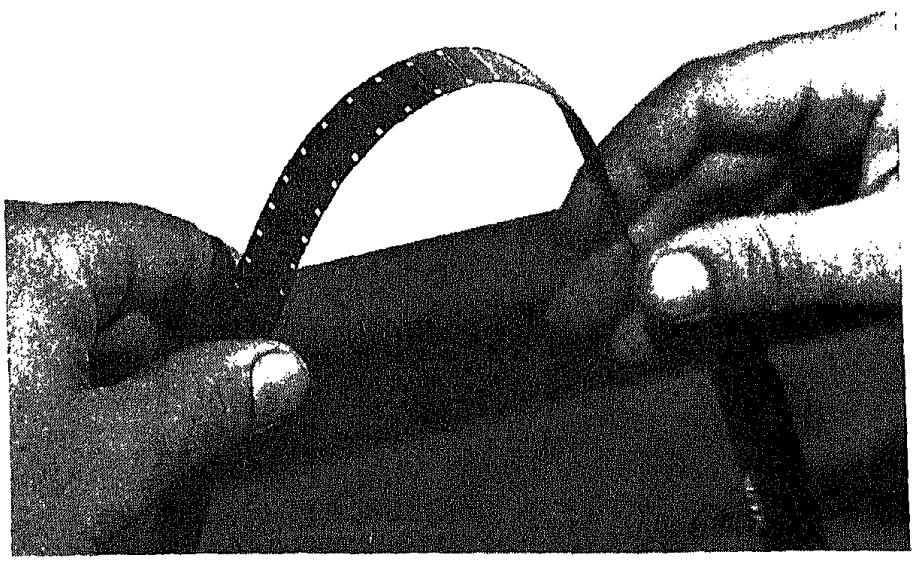
Cement should be applied by brush to the prepared surface—enough to wet the complete splice area, but not so much that cement will run outside the splice when the two films are pressed together. It is important that you close the splicer and bring the two films into contact as soon as possible after cement has been applied and keep the film under pressure for 15 to 20 seconds (8 to 10 seconds for a hot splicer).

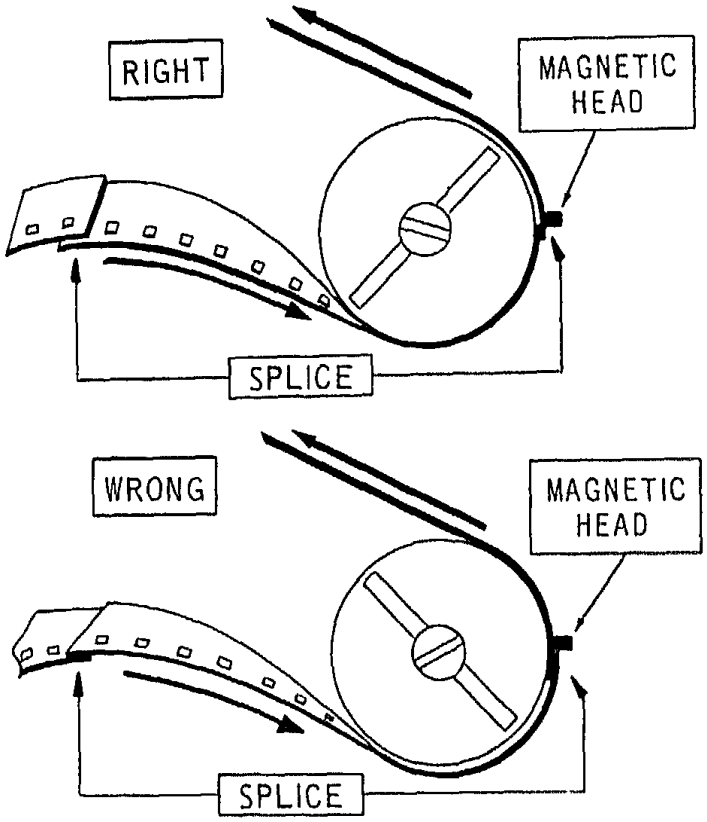
The body and viscosity of most film cements are such that little or no cement will be squeezed out of the overlap when splices are made properly; but if any is, the excess must be wiped off immediately with a soft cloth. Otherwise, it may adhere to and leave a smear on the preceding or following convolution of film in the reel, causing damage, distortion, or wrinkle.

Films that have become very dry or that have been rolled on small-diameter reel hubs can develop so much curl that splicing becomes difficult. Such films should be held under pressure in the splicer 30 seconds or longer (15 seconds with a hot splicer) after the cement has been applied, to allow the splice to develop adequate strength.

A good splice has sufficient strength after 20 seconds to allow the film to be removed from the splicing block and wound onto the reel at normal tension.

Examine each splice for quality. A good splice is fully transparent; bubbles and hazy areas indicate a poor splice. A freshly made splice should not be tested by scraping or pulling at the weld; instead, test the splice by flexing. The splice should be slightly stiffer than the single thickness of film.






Lap the film ends so that the butt of the splice is away from the magnetic head. (The "step" in the splice is greatly exaggerated for clarity.)

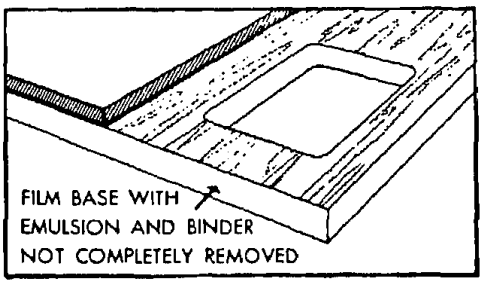
If the metal in the splicer becomes magnetized, a noticeable click may be heard in films that have a magnetic sound track. If this proves to be a problem, the splicer must be demagnetized.

Film that has an optical sound track can be spliced without any special attention to the direction of the splice butt, because the optical sound track is essentially a part of the film emulsion. Use blooping ink on optical sound film splices to eliminate pops and clicks caused by abrupt changes in the sound track modulation at the splice.

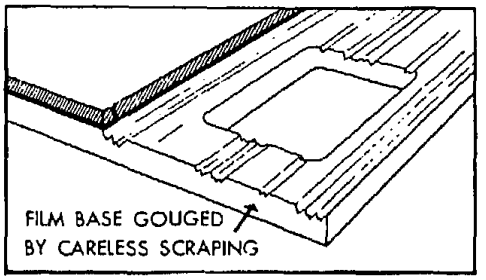
Some of the most common causes of unsatisfactory cement splices are:

- Insufficient drying time.

● Emulsion or binder remaining on the base in the prepared area causing an incomplete or poor weld.




● Excessive scraping, scratching, or gouging of the film base, which weakens the base and causes the film to break.




● Too much delay in bringing the film ends into contact after the cement has been applied.

● Applying too much cement, causing the film to buckle. After a short time, this will create difficulty when the film passes through the projector gate.

● Applying too little cement, resulting in an incomplete weld over the entire area of the splice. Such splices should be made again, or the film edges will come loose and tear easily.

● Using the wrong cement for a particular film base.

● Poor mechanical adjustment of the splicer, causing misalignment of the film ends, inadequate or uneven pressure, etc.

Here are some hints to help you use film cement better.

● Keep the splice clamped for 15 to 20 seconds (8 to 10 seconds in a hot splicer) after the film ends have been joined together. Insufficient drying time is the greatest single cause of splice failure.

● Never add new cement to old in a work bottle. Carefully clean out all the old and start with fresh cement daily.

**cement evaporates rapidly.**

- **Keep the cement fresh and pure.**

- **Check the age and condition of the film. It will be necessary to remove any base coating by scraping or by applying and wiping off film cement in the splice area.**

- **When scraping, do not remove more than the emulsion and binder. Remember that gouging the film base will weaken the splice.**

- **Keep the splicer scrupulously clean. A buildup of film cement on the knife edge, upper pressure clamp, or pin support block can cause a poor splice. To clean off dried cement, saturate it with wet cement and wipe off with a clean cloth. Never scratch the splicer.**

- **Avoid fingerprinting the film; wear lint-free gloves.**

## Negative Cutting

After you have completed editing the workprint, the original camera footage must be cut to match it. This cutting of the original is known as *conforming* or *negative cutting* (even when the original is in positive form). Negative cutting is done by matching the original film to the edited workprint by comparing numbers on the edge of the films. These numbers are printed on the edge of the original film during manufacture. When the film is processed, the *edge numbers* become visible, and, when a copy is made, they are also visible in the copy or workprint. It is then a simple case of matching the edge numbers—number for number—and cutting and splicing the original film to match the workprint frame for frame. When the original and workprint match, release prints are made from the original onto a reel of new stock film, free of splices.

There are two ways of neg cutting. One is *single-roll cutting*, that is, you end up with a roll of cut original film that matches the workprint shot for shot. Single-roll cutting is suitable whether the original footage is negative or positive. However, when negative-type film is single-roll cut, the splices tend to "flash"—that is, they show up as white lines on the screen. For this reason, it is common professional practice to cut the original film on two rolls; i.e., *double-roll cutting*. Both methods, single-roll and double-roll, require similar techniques. And, in both cases, the primary objective is to produce an exact match, frame for frame, between the workprint and the original film.

SINGLE-ROLL CUTTING.—For single-roll negative cutting, you will need a two-gang synchronizer with film rewinds on each side, a cement splicer, editing gloves, and an absolutely clean editing table.

You will begin your single-roll cutting by first putting the workprint on the synchronizer and going through it from the head writing down the edge numbers of the in-point and out-point of each shot, *accurate to the frame*, so you have a complete and accurate log of the film. Next, using your film log, arrange a shot list in numerical order so the original film can be arranged in proper edge number sequence as it is cut apart. *The edge number* sequence of the original *may not match the edge number* sequence of the workprint because during assembly of the workprint, you may have rearranged or changed the order of the shots. Thus, your shot list may look like this:

| SHOT | IN EDGE NUMBER | OUT EDGE NUMBER |
|---|---|---|
| 1 | LA2181073 | LA2181099 |
| 2 | LA2181763 | LA2181880 |
| 3 | LA2181100 | LA2181273 |
| 4 | LA2181896 | LA2181947 |

*Notice that the edge numbers of shot 3 are out of sequence as compared to the other shots. Thus, when the original film is cut apart, it will be hung in the clean film bin in shot order sequence by cross-referencing edge numbers to the shot numbers.*

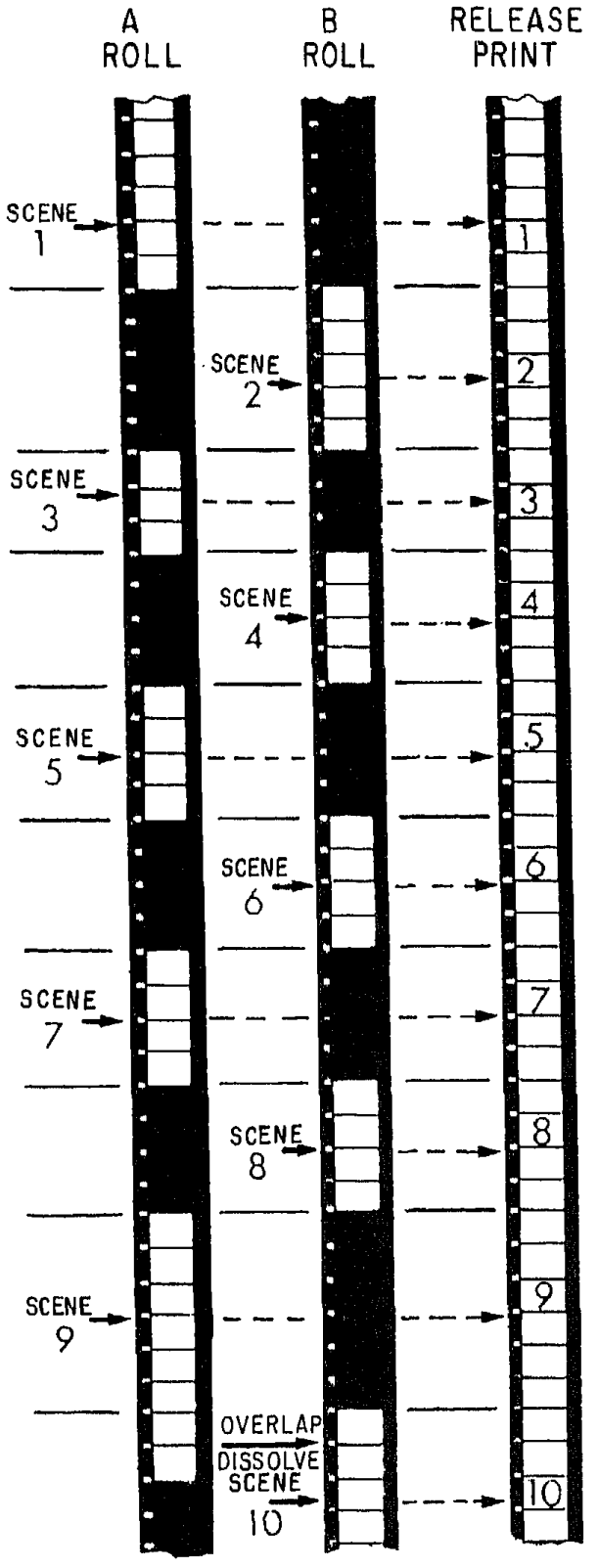
Now with the original film on one of the editing table rewinds, cut each shot you need from the roll and, by referring to the shot list and film log, hang each shot on its appropriate shot number film bin peg. If the shot you are cutting out of the original is adjacent to shots which will not be used, you should cut out a generous leeway on either end—this may safeguard against cutting the needed shot too short from the original.

After all the required shots have been cut from the original and are hung in proper shot order, wind the workprint back to the beginning, put it on the back gang of the synchronizer, and begin assembling the original film on the front gang—taking shots one by one from their numbered pegs. Use cement to splice the original film together. As the two lengths of film move through the synchronizer, check to make sure there is exact sync between every frame on the original and the workprint.

DOUBLE-ROLL CUTTING.—To avoid the possibility of release prints having the visible splice marks associated with single-roll cutting, use the double-roll cutting method. To avoid the visible splices, the original film is cut into two separate but parallel rolls—thus the term *double-roll* or *checkerboard* or *A and B rolling*. Each successive shot is assembled onto an alternate roll, and the section of the other roll opposite a shot is filled with black opaque spacing to match.

To print the release print, each roll of original is passed through the printer—one roll at a time. The print stock is passed through the printer twice. The opaque spacings in the A roll prevent exposures of the adjacent print stock which is then exposed when the B roll is passed through the printer with the second run of the print stock.

Double-roll negative cutting permits smooth dissolves to be made during printing by overlapping the tail of one shot with the head of the next. Thus, when printed, the first shot fades out and the second shot fades in.




**Double-roll, checkerboard, or A and B roll negatives cutting. The scenes in the original film are assembled onto alternating A and B rolls. Black leader is used between shots and overlaps the splice in the direction of the leader that parallels the following shot, thus, preventing a flash mark.**

Printing motion picture films is essentially the same as printing still picture films. The primary difference being the medium to which the image is transferred. In still photography, the print image is usually made on an emulsion-coated paper, and the image is viewed by reflected light. In mopic work, the image is printed onto an emulsion-coated transparent base, and the image is viewed by transmitted light.

Motion pictures are printed on special motion picture printers of which there are two basic types—contact and optical. In a motion picture contact printer, the original film and the raw print stock pass, emulsion to emulsion, past the exposing light. The light shines through the original and exposes the print stock accordingly. The size of the original and print stock must, of course, be the same. In other words, 16mm original is contact printed onto 16mm print stock, Super 8 original onto Super 8 print stock, etc. Contact printing is the most widely used mopic printing method and produces 1:1 images.

Unlike contact printing, in optical printing, the original film is not in physical contact with the print stock during actual exposure. Instead, the original image is "photographed" or projected through an optical system and the image recorded on the print stock. Depending on the model or design of the optical printer, 16mm original film images, for example, can be printed onto 35mm, or Super 8, etc., print stock, or 35mm or Super 8 originals can be printed onto 16mm film.

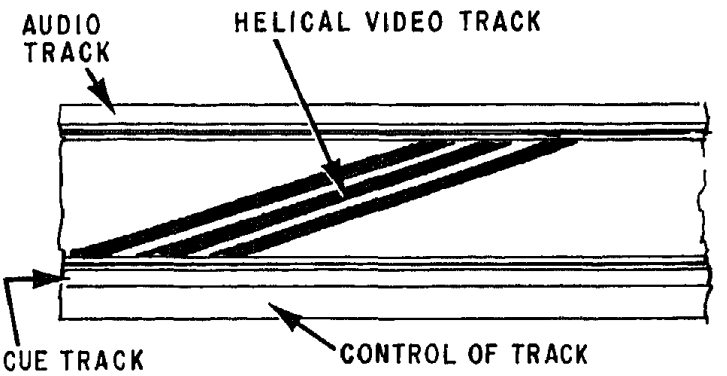
## TELEVISION PRODUCTION

Television production is very similar to mopic production—scripting, directing, camera techniques, etc., are basically the same. The one significant difference between TV and motion picture production is the visual recording medium. Although a TV program can be recorded (shot) on film, and many are, the vast majority of *nonlive* TV programs are recorded on videotape. Therefore, our discussion of TV productions in this chapter will be limited to videotape recording (VTR) and videotape editing.

## VIDEOTAPE RECORDING

Videotape recording is very similar to audiotape recording. Electronic impulses of the television camera images and sound are recorded onto a magnetic videotape, which can be played back later, converting the recorded signals into picture and sound. The basic system of videotape recording in the Navy is the *helical* or *slant-track* process, either 1/2 inch or 3/4 inch.

In the helical or slant-track VTR process, two rotating video recording heads put the video signal on the tape in a diagonal manner as the tape moves past the heads. The audio, cue, and control tracks are put on by one or more nonrotating heads.




3/4" INCH VIDEO TAPE FOR HELICAL SCANNING

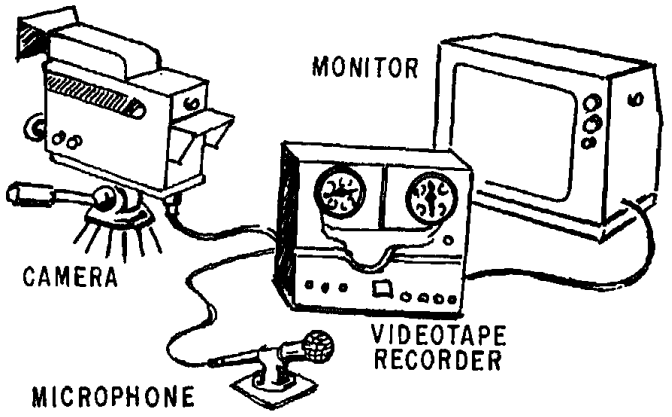
### Videotape Production Equipment

There are four essential components to a videotape recording system:

- *Camera*—The TV camera receives visual images and converts them into electrical impulses that are sent through a cable to the videotape recorder.

- *Microphone*—The microphone receives sound waves and converts them into electrical impulses which are sent through another cable to the videotape recorder.

- *Videotape Recorder* (VTR)—A videotape recorder converts the electrical impulses from the camera and microphone into a magnetic force resulting in a magnetic pattern on the tape surface. The recorder's *playback* head convert the magnetic patterns back into electrical impulses.




These impulses are sent through a cable to the television monitor.

● *Monitor*—A monitor or receiver (the TV set) receives the electrical impulses from the recorder/playback and converts them into visual signals on the picture tube and sound through the speaker.

**Recording With Videotape**

A novice to videotape recording may believe that, like in mopic work, one scene can be recorded, the TV camera and tape recorder stopped, the next scene set up and shot, etc., until all the scenes in the script have been recorded. This misconception probably comes from the fact that TV and mopic images are quite similar in their *visual* appearance. The results of this record-stop—record-stop method of videotaping the scenes of a script are not, as might be expected, an in-camera-edited tape ready for immediate showing. In fact, when this procedure is used, and the tape is not further edited, the results are usually unprofessional. Even though adjacent shots may have the correct visual relationship, be the right length, etc., the electronic impulses become discontinuous, and each scene change is evidenced by a rolling of the TV picture and other disturbances.

To prevent this problem in videotaping, two methods can be used which will give the final recording a smooth-flowing, uninterrupted polish.

SEQUENTIAL SHOOTING/STUDIO RECORDING.—When the TV production can be recorded either in the studio or from a mobile van, two or more cameras can be used—one for the LSs of the subject, one for the CUs of the subject, etc. For example, all the TV cameras, those focused on the graphics, as well as the telecine chain, if required, plus the subject cameras, are connected to the videotape recorder through the video mixing console where the video engineer controls what is actually recorded on tape. With this procedure, all the cameras and the recorder are left on during the entire sequence, segment, or production. The video engineer, either of his own accord or at the direction of the director, "feeds" the signals from the various cameras to the constantly running recorder, thus eliminating the disturbances caused by interruptions of the electronic signals.

NONSEQUENTIAL SHOOTING/LOCATION RECORDING.—Another method of producing professional quality videotape recordings uses a single camera connected to a recorder. Generally speaking, a portable camera and VTR are used at remote locations, often operated by one person. In this, the nonsequential shooting or location recording method, you will use the stop-record—stop-record procedure we faulted earlier. However, your goal is NOT to produce an "in-camera-edited" video recording. You will use the single camera to shoot your scenes in any convenient order. You will shoot as many "takes" as necessary, because the tape will be edited later in the production sequence. You should start the camera/recorder *at least* 10 seconds before the scene action starts and allow it to run 10 seconds after the action ends. By following this procedure, you will have enough tape for editing on either end of the scene.

**VIDEOTAPE EDITING**

Editing videotape, like editing motion pictures, is a process of shortening, rearranging, and deleting material to produce an effective communication medium. In motion picture production, editing involves physically cutting and rejoining the film. The editing process with videotape, on the other hand, does not *usually*

involve cutting and splicing—editing is done electronically.

> Videotape can be mechanically edited, however, this procedure is considerably more complicated than film splicing or electronic videotape editing and is not generally in wide use.

The basic equipment needed for electronically editing videotape is:

- A videotape recorder/player (VTR) or a videotape cassette recorder/player (VCR) machine to play back recorded scenes.

- An editing VTR or VCR to record selected scenes from the player unit. The editing VTR or VCR must have features which include provisions to record audio and video tracks separately and/or simultaneously. It must be able to lock on electronically to the video signal from the player so that when a scene from the player is recorded, it is recorded from its first to last scene and is smoothly added to the master tape without any distortion.

- An editing control unit that allows precise location of the beginning and ending of scenes and controls the cueing of the player and recording VTRs/VCRs.

Additional equipment which might be used for videotape editing can include:

- A sync generator to stabilize the electronic signals throughout all the editing equipment.

- Video and audio mixers to combine material from several tapes into one tape.

- A special effects generator to produce fades and dissolves and other special effects.

- A titler or character generator for inserting titles or captions, etc., into the master tape during editing.

Essentially, electronic editing of videotape is a transfer process in which a playback VTR or VCR unit containing the recorded scenes or shots is used to transfer program segments onto an edit/record VTR or VCR unit. The various takes are assembled into a completed production on the edit/record unit.

Before you begin the actual editing or transfer process, you should view the tape that was shot and become familiar with its content. Review the program script as well as the shot log. Make notes of any changes that should be made in the script; e.g., unscripted scenes that were shot, retakes of scenes, and any scenes or shots which were combined or eliminated. Mark the script with the tape reel or cassette number and the footage location of each scene and which shot to use. The shooting script is now your editing script.

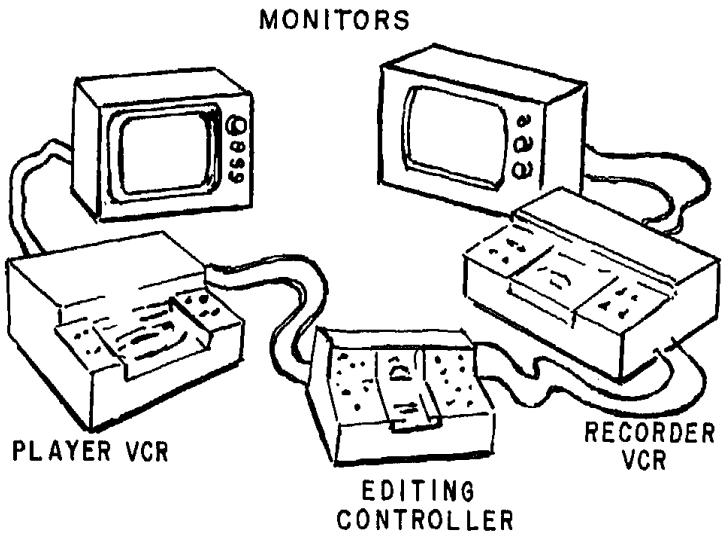
Videotape editing is divided into two distinct parts. The first part is the decision process wherein you must decide such things as the program content, and the pace, flow, and continuity of the production. You must select the takes to use and decide in what order to use them. You will have to decide on scene length or what portion of a scene to use. You will decide the need for and the placement of titles, captions, special effects, etc.

The other part of videotape editing is technical, or the switching process—wherein each shot from the camera "roughs" are transferred, in proper sequence, to the master tape.

Various editing procedures can be used. In the *manual* controlled system, the editor controls exactly where and when the edit will take place as the playback and edit/record tape machines are rolling. The other method or *programmed* electronic editing eliminates the imprecision of the manual controlled system by enabling you to program the exact point where the edit is to take place. In the programmed method, an editing controller is connected between the playback and edit/record VTRs.

Programmed electronic editing is the method most commonly used today. It follows, essentially, this procedure:

1. Place a high-quality videotape on the edit/record VTR/VCR. This will be your final *master* tape.
2. Transfer the first scene you want to use from the playback unit to the master tape. Rewind the master exactly to the last frame of scene 1.
3. On the playback unit, find the first frame for the second scene you want to use.




4. Rehearse the transfer of the second scene by watching the transition from scene 1 to scene 2 on a monitor.

5. With both the scenes reset as in 2 and 3 above, rewind the playback and edit/record units for exactly 5 seconds of tape.

6. Start both machines playing forward.

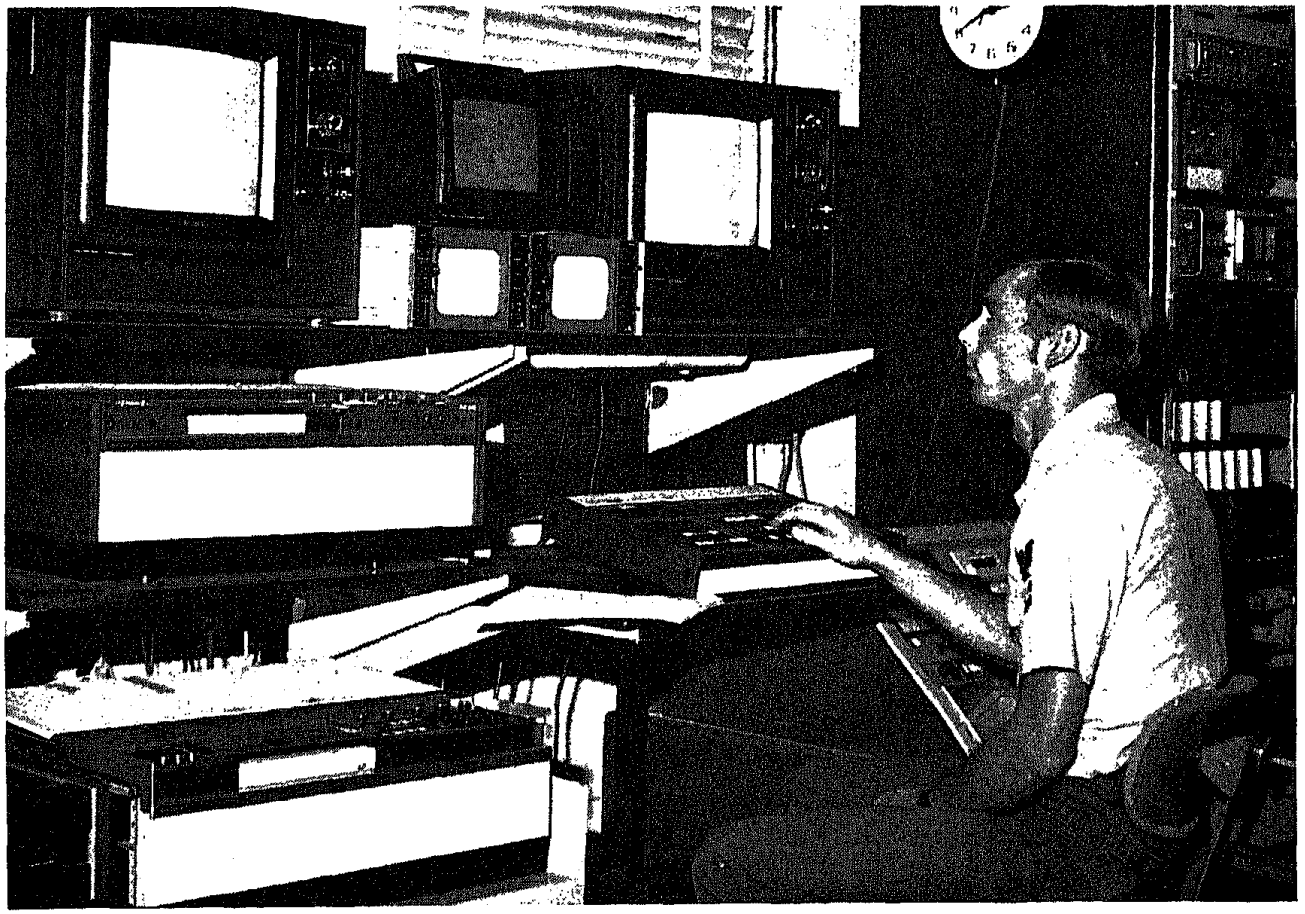
7. At the *edit point* push the record button on the edit/record VTR.

8. View the edit on the monitor.

9. If acceptable, proceed to the next scene.

Various levels of editing equipment are available. We have not given specifics of the operation of any machines because, although they are basically the same, each model has its own features and functions which may differ from those of another. Each piece of editing equipment is supplied with an instruction and operations manual which you should consult before interconnecting or operating the equipment.

Once you have assembled your master recording, you can make one or more duplicate recordings. The master recording is not normally used for viewing because it could become damaged. The master recording should be considered "protected" and stored in a safe place while the second generation or copies of the master are used for showings.



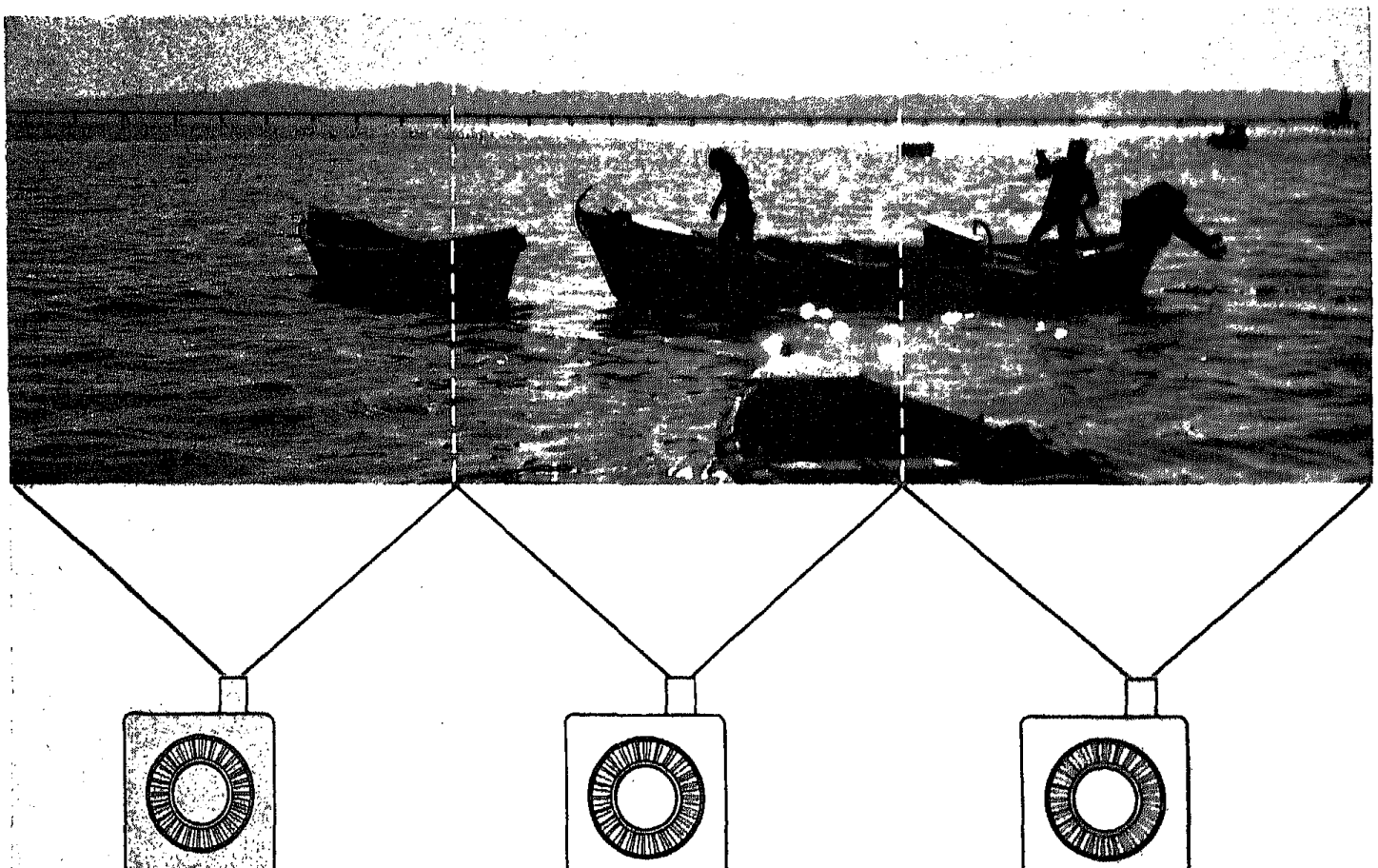
## MULTI-IMAGE PRODUCTION

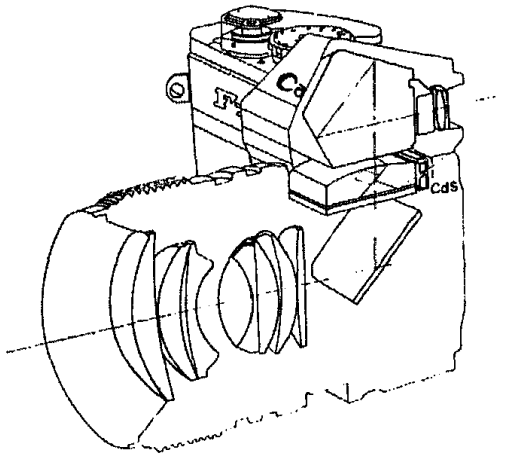
In a multi-image presentation, the viewer is presented with a series of changing images. Sometimes the entire screen may be filled with one or more images, sometimes only a part of the screen may have an image, and sometimes the images may flash on and off the screen and appear to create motion. A multi-image show requires the viewer to get "involved" by actively following the message or images contained in the show. The viewer may have to select the *primary* image from among almost any number of support images, exercising personal preference or accepting clues from the images and accompanying sound.

Multi-image presentations, perhaps more than any other AV presentation method, offers you, the photographer or producer, almost unlimited opportunities for artistic expression. You may use a broad array of images combined with almost unlimited sound possibilities to present a sweep of images that move and tempt the viewer and convey ideas and messages very effectively. Your skillful use of images, timing, sequencing, and sound can influence the audience by an almost endless series of progressions.

Although multi-image presentations have been around for many years, they are relatively new in our Navy. There is a growing acceptance of multi-image in our Navy, and for good reason. Multi-image does have advantages for communication beyond that of motion pictures and television.

These advantages become very self-evident when there is a simultaneous presentation of images by a minimum of three projectors. Multiprojector shows not only sustain interest better, but interest can be held and influenced in novel ways. This is not to say, however, that a three-projector multi-image show is the "best" multi-image show. Far be it for anyone to say with any validity that a given number of projectors always makes the best show. Each show must be planned, evaluated, and executed separately—with the ideal number of projectors, be it 2 or 22,




Cds

Canon
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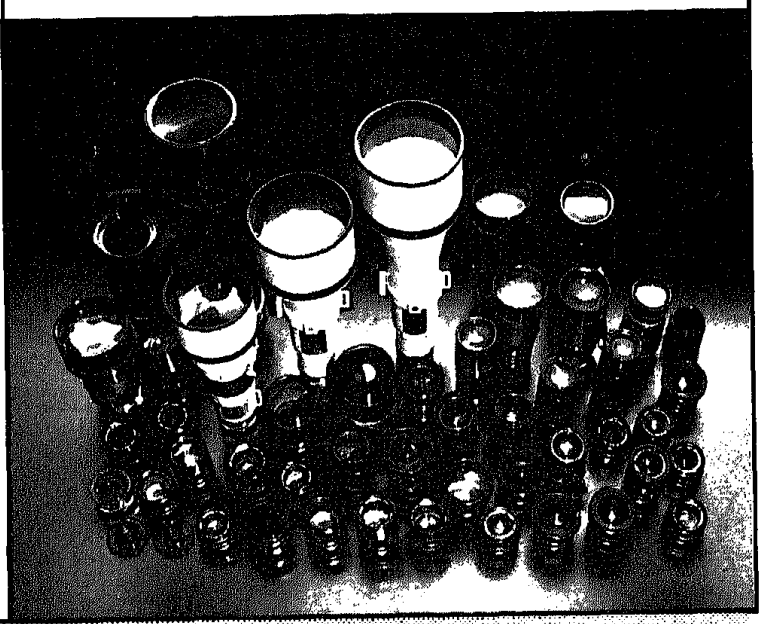
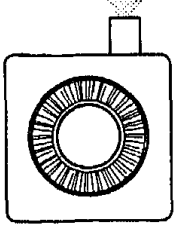
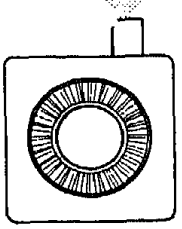






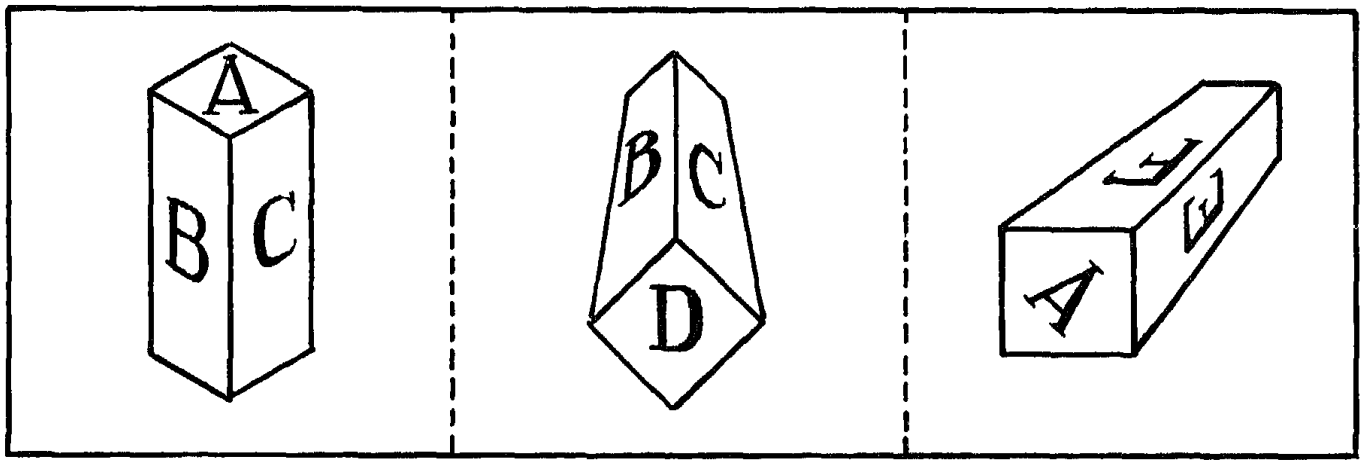
determined on the merits of what each lends to accomplishing the purpose and objectives of the show.

Critics often say that making multi-image presentations requires a lot of time and effort. They also point out that multi-image is often a costly way of saying something that might be said with one image, such as TV or motion picture. These concerns may be justified in light of the cost and manpower commitment required to produce professional quality multi-image presentations. The important factor lies in your attitude and that of your client or the requestor of the presentation. That is, what do you and the client want to say? And, how do you want to say it? You CAN justify the time, effort, and cost of multi-image when objectives seem to call for this type of AV presentation. Therefore, before you decide to make a multi-image production, you and the client must satisfactorily answer the question, "WHY use multi-image?"

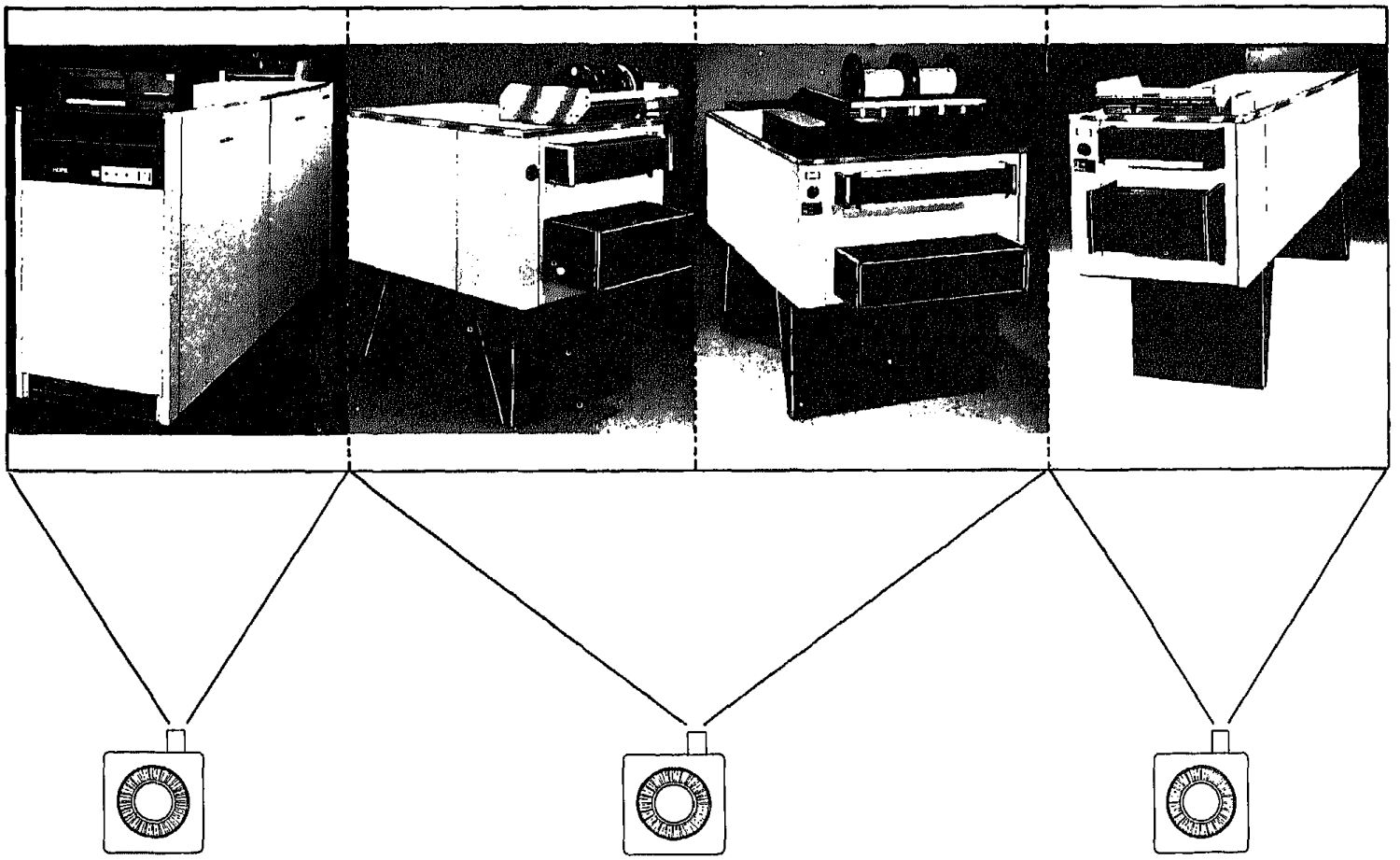
Some of your strongest reasons for using multi-image may range from the medium's impact and emotional appeal to its effectiveness as a tool for instruction. Even its uniqueness as an AV presentation method can be a valid justification for its use. The uniqueness of multi-image can help to present feeling, to visually motivate the audience, and to provoke the viewer's thought, sight, and hearing. Not only does multi-image have strong attention-getting attributes, there are also several other substantial reasons for selecting multi-image. Some of its strengths are:

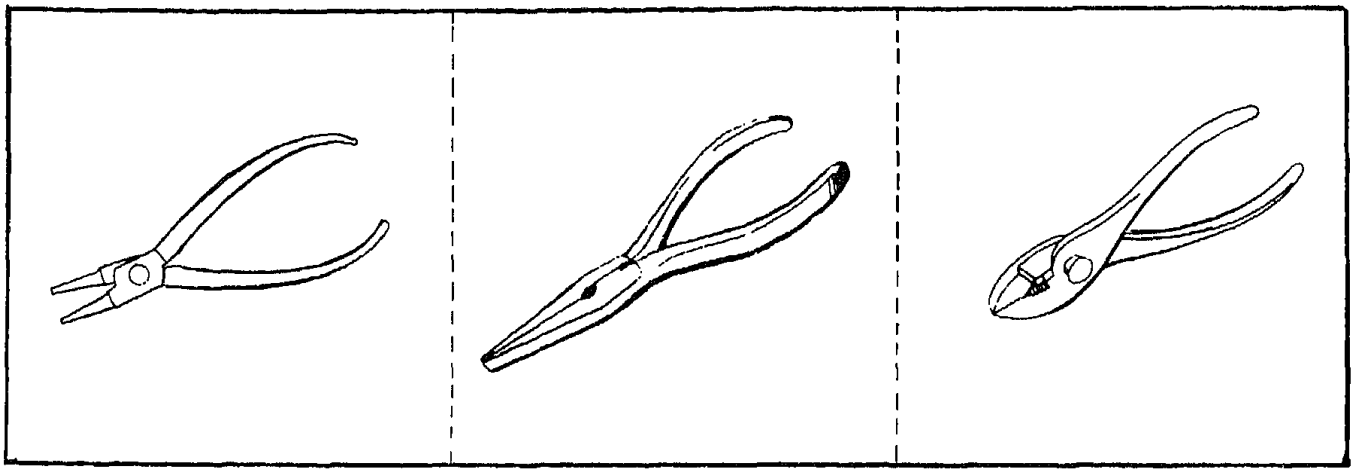
- *Sequence of Presentation*: With proper sequencing of the visuals, you can sustain the

several different points of view. The different camera angles may help alter the viewer's impression and understanding of the scene.

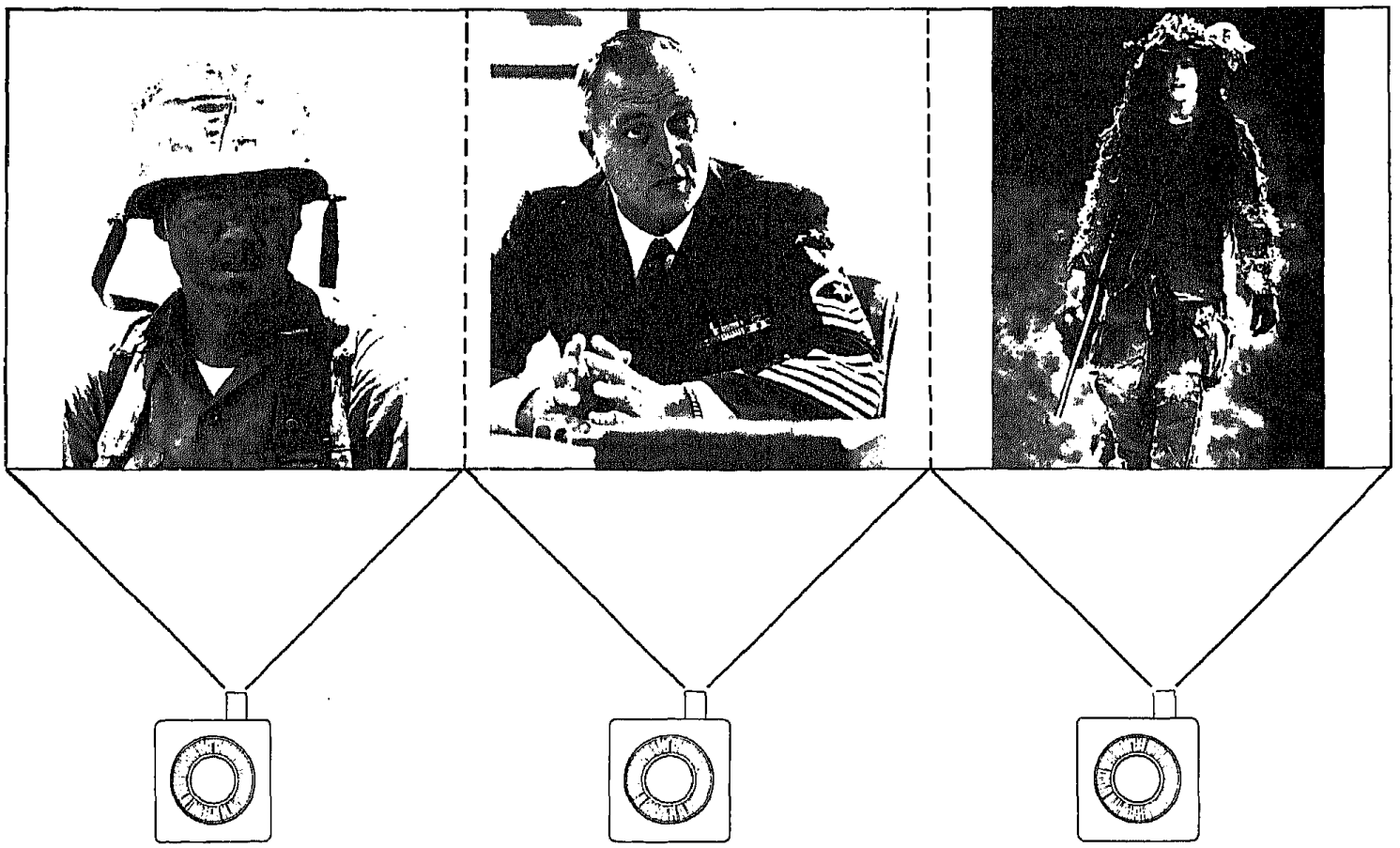



● *Adjacency*: By positioning visuals simultaneously next to one another on the screen, various relationships among them can be made more obvious than is possible when the viewer must remember preceding visuals. Adjacent visuals can vary in size, shape, and screen position.



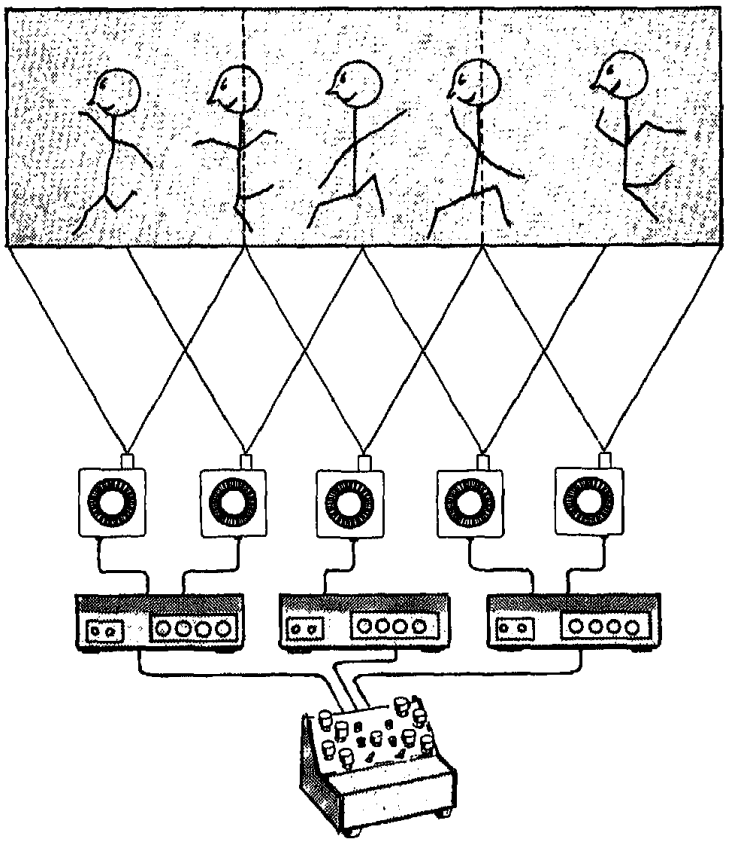


● *Contrast*: The audience is better able to compare or identify differences when several visuals can be viewed simultaneously.

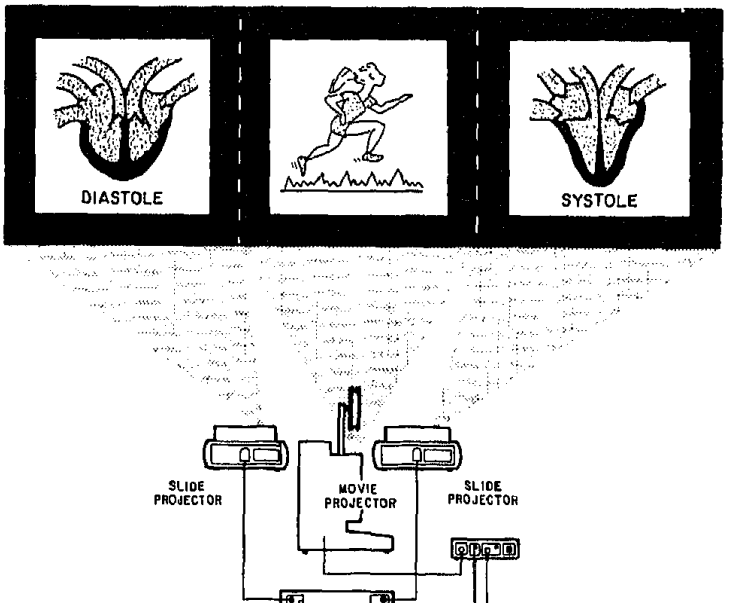


● *Emphasis*: A specific visual can be emphasized and the audience's attention focused upon it by organizing the composition or screen position of multiple images of the same theme. The specific visual can be held center screen, for example, while similar or support visuals fade and dissolve.

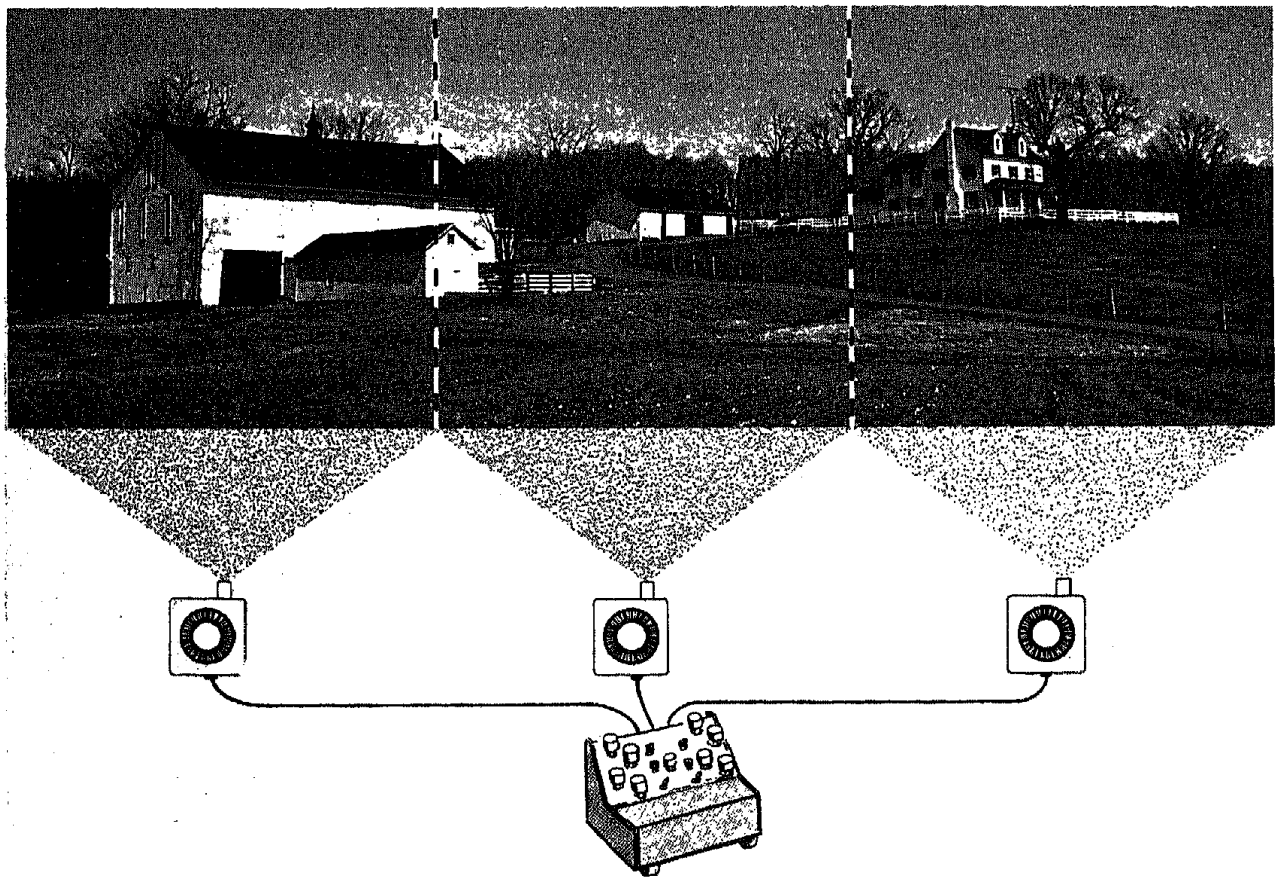
● *Motion Simulation*: Through the use of a series of rapidly changing images the visual impression of motion can be created.



● *Combining Still and Motion Picture Visuals*: Motion picture images can be projected onto part of the viewing area while still picture images of the same or different scenes can be projected on other viewing areas.



● *Panorama*. Through the use of several projectors a wide angle mosaic view of a scene can be presented.



Good multi-image productions rely on combining the *best* of audio and visual communications to achieve the program objectives. The very best, most sophisticated, most expensive multi-image hardware is only as good as the "software" (images and sound) it displays. To produce effective, professional quality multi-image presentations, you must give strict attention to the creation of both the audio and visual aspects. Also to be considered throughout the production process is the physical arrangement required to present the show; i.e., the physical arrangement of the presentation equipment and the surroundings or room where the show is to be put on.

A multi-image production has certain basic steps which must be performed. However, *technique* and *style* play an important role in the development of a successful multi-image production.

## AUDIO

The audio or sound can make or break the production. If you do not fully appreciate the importance of audio, try watching a TV show without the sound. Then, try listening without seeing the picture. It will be clear to you that communication relies most heavily on hearing rather than seeing. This is not to say, however, that the quality of the sound should be better than the quality of the visuals. The only way to have a quality presentation is for both the sound and picture to be "*quality.*"

any combination of these.

### Music

Although the visuals can help set or establish the mood and pace of a presentation, music is the *key* to establishing the pace. Music must be selected carefully. It can be "borrowed" from prerecorded sources. When selecting the music, keep the visuals in mind. Certain visuals may dictate the type of music needed—and sometimes a score of music may give rise to new visual ideas.

### Narration

A narrated program can be very cost-effective. This type of multi-image presentation is relatively simple to produce; however, without a well-written script and good delivery by the narrator, it risks losing the audience's attention—especially if the presentation is long.

The audience must be kept foremost in your mind while selecting the "voice" for the narration. A young audience may be "turned off" by an older authoritative voice and an older audience may be turned off by a young voice.

The narration should be recorded in a studio or in isolation from extraneous noises that would degrade the program. Use high-quality sound recording equipment and be ready to re-record until the audio is correct.

### Documentary

A very effective audio communication is the documentary approach. This technique of audio communication involves location recording of real-life/real-time sounds. It means foregoing a formal script and letting the subjects speak their own words—their own way. Documentary audio recording usually requires substantial production time and editing. However, when resources permit, the effort involved is well worth it.

A documentary audio recording as part of the multi-image production can help make the audience feel as if they are part of the action. In other words, it tends to draw them into the presentation, and when people are "part" of the communication, it has more significance to them and they are more attentive.

### Combined Music, Narration, and Documentary

When any or all of the audio techniques are combined, the assistance of an audio engineer and audio production facilities is almost a requirement. The techniques of combining sound from several sources require the use of a sound mixing equipment which can bring the various sounds together to the proper volume to achieve the desired effect.

## VISUALS

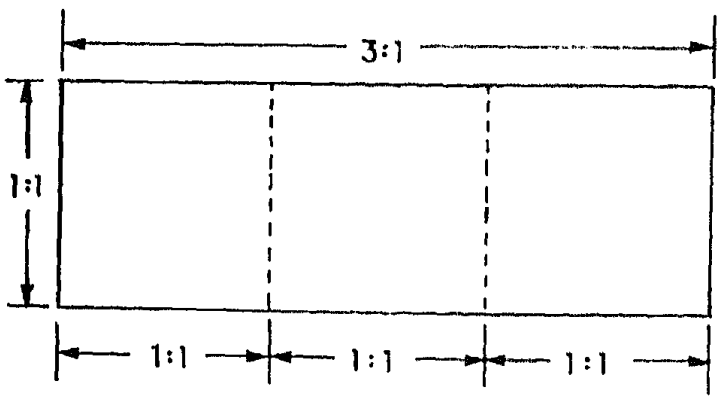
The configuration of the viewing screen, screens, or screen areas figures in the planning and production of any multi-image presentation. A primary question is "How many screens or how big a screen or how many screen

screens or the amount of screen area to use. Some of the things to consider are:

- The purpose or objectives of the presentation.
- The producer's skill, experience, and technical knowledge.
- The equipment available.
- The physical layout and size of the eventual viewing area.
- The portability of the presentation. Will the show be taken on the road? The more screens or the larger the screen area, the more projectors generally required and thus the less portable the presentation.

These considerations are not listed in priority order. They should all be considered on an individual basis—one having priority over another at one time and then possibly being subordinate to another at another time. As a good rule of thumb it is wise to use the minimum number of screens or screen areas that are not too large. Remember, the total screen area must be large enough to permit big enough images so the audience seated at the back of the viewing room can *easily* see the screen images.

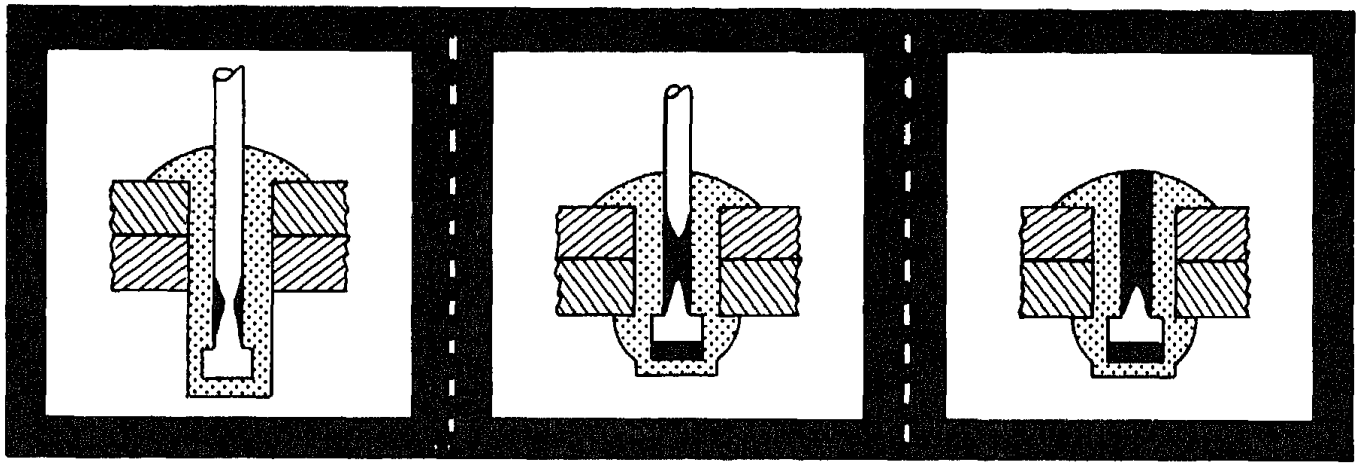
For most multi-image shows, a single screen with an aspect ratio format of 3:1 is probably adequate and desirable. "Multi-image" is achieved through the use of multiple projectors—*not* multiple screens. However, when multiple screens or very large screen areas are needed because of the demands of the presentation objectives and the real need for full impact, it is usually recommended that not more than three image areas or screens be used. This is because:



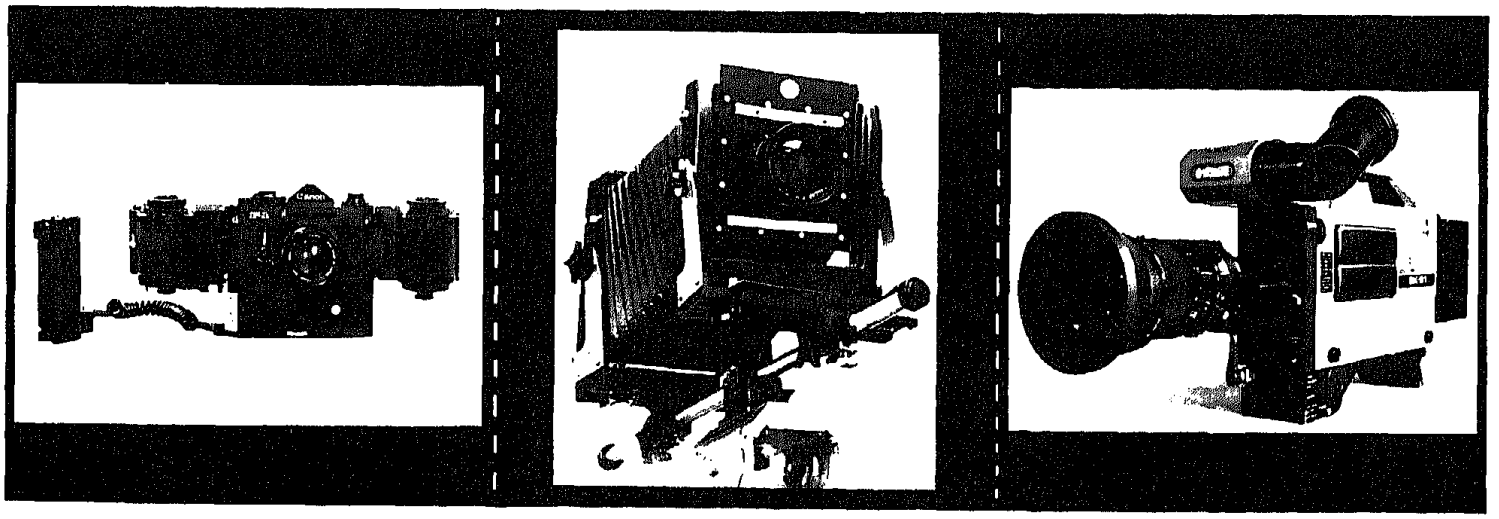

**Multi-image projection screen with a 3:1 aspect ratio.**

- Most viewing areas (rooms, etc.) can't accommodate more screen than three image areas.

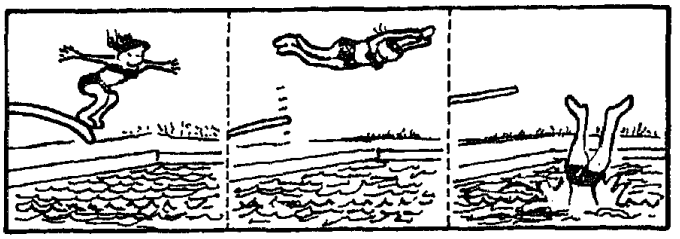
● The three screen/image area contributes to the visualization of steps in a process and has strong communications value.



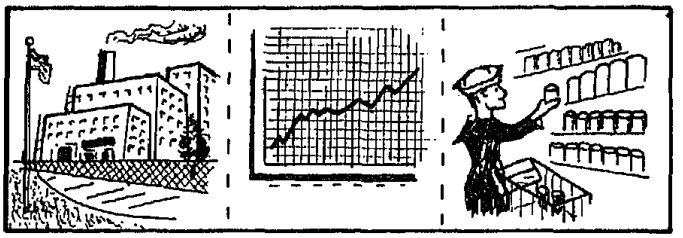
● The three screen/image area concept is good for showing comparisons and contrast.



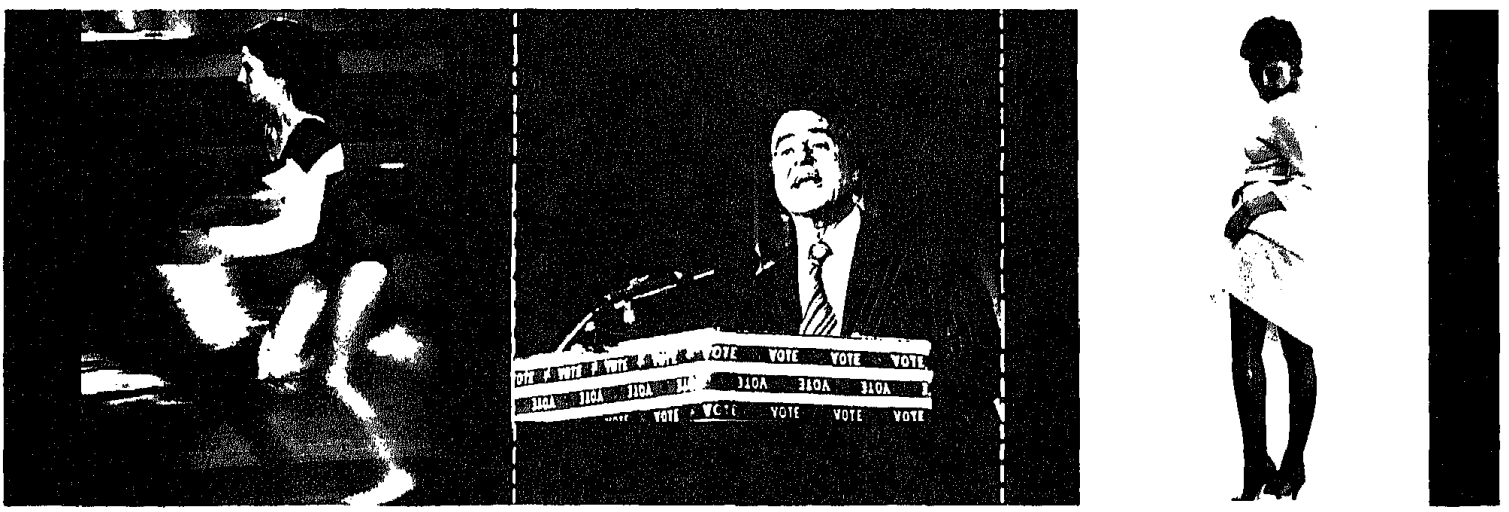
● The three screen/image area can be used to simulate motion of a still subject across the multiple screen/areas.



● The three screen/image area gives meaning to an abstract idea with several supporting visuals.



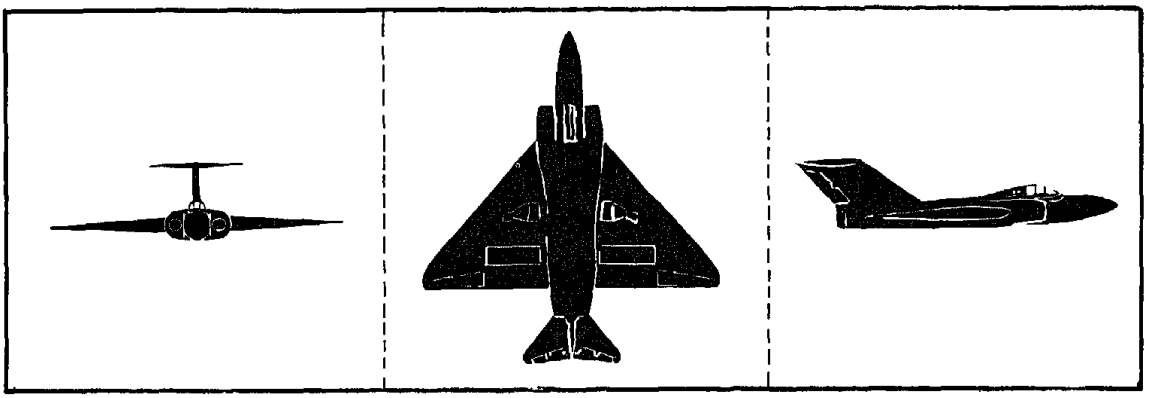
● The three screen/image area can be used to show different meanings for the same word.



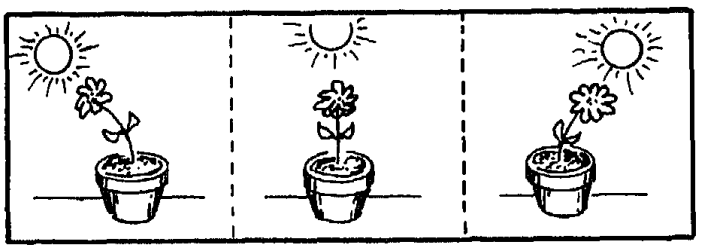

**RUN**
**(FAST)**

**RUN**
**(FOR OFFICE)**

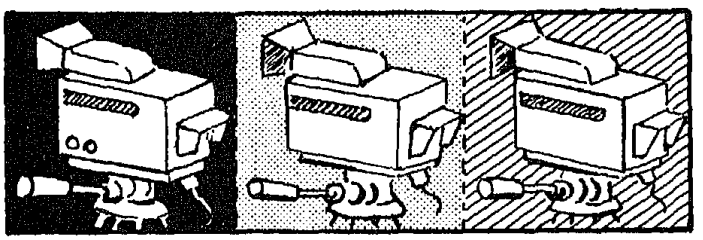
**RUN**
**(IN HER STOCKINGS)**



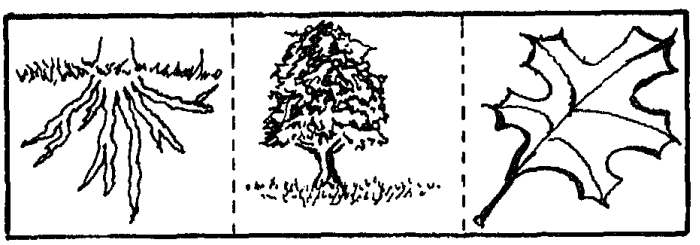
● The three screen/image area can be used effectively to show sequential time segments relating to a single event.



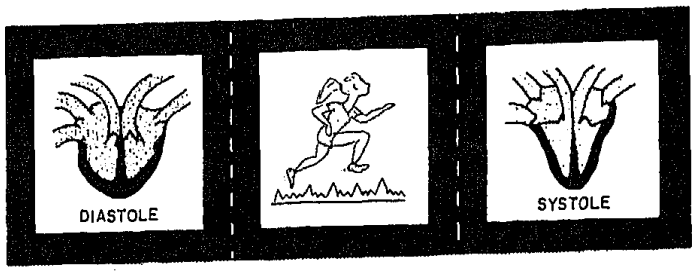
● The three screen/image area serves well to emphasize a fact or concept by repeating the same subject image.

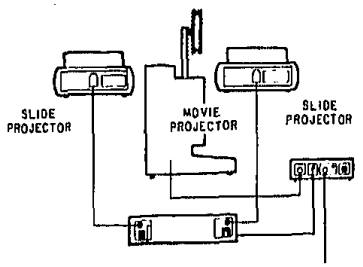


● The three screen/image area works well to show relating parts of a subject to the whole.



● The three screen/image area can combine motion picture and still picture images.

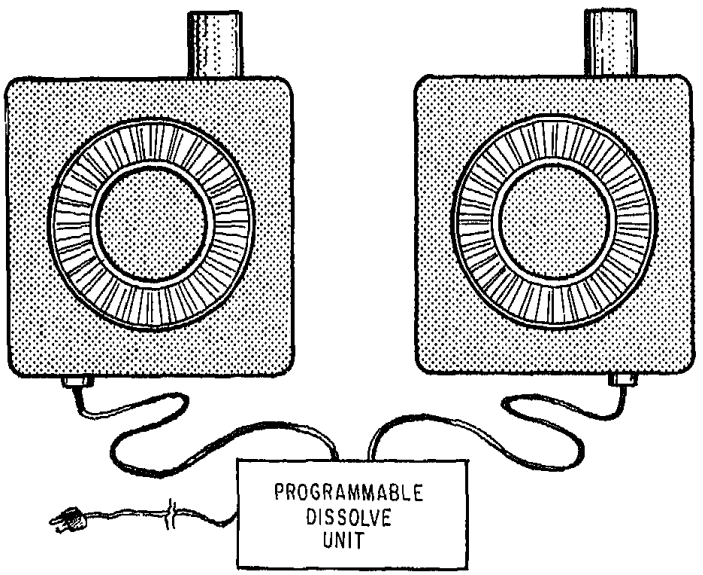



## Still Image Dissolves

The concept of dissolves for multi-image stills is "borrowed" from the motion picture industry. The still-picture dissolve technique and the equipment for dissolves are an integral part of multi-image. Still-picture dissolving is the "blending" from one still image to another without the single projector's "click/black/click" between successive screen images. A dissolve is accomplished by connecting two or more still projectors to a programmed dissolve unit.

A dissolve unit is an electronic device containing oppositely gauged dimmer-type switches. The dissolve unit changes the dimmer settings which in turn increase the electrical power to the lamp in one projector while decreasing the power to another projector. This turns the lamp in one projector "up" while turning the lamp in another projector "down." This results in the gradual brightening of one image while the other image fades, thus creating a transition of visuals from one projector to another.




By proper treatment of the still photography, you can simulate a zoom effect with the dissolve technique. Color transition is also possible. For example, a red area of the slide in projector number one can be aligned with the green area of a slide in projector number two, thus the colors would pass through yellow during the dissolve. Fades up from or to black can be produced by using a blank or opaque slide in one projector.

Also borrowed from motion pictures is the multi-image technique of superimposition. This technique places two still images on the same screen area simultaneously. Superimposition is most useful in titling and very effective in creating special effects.

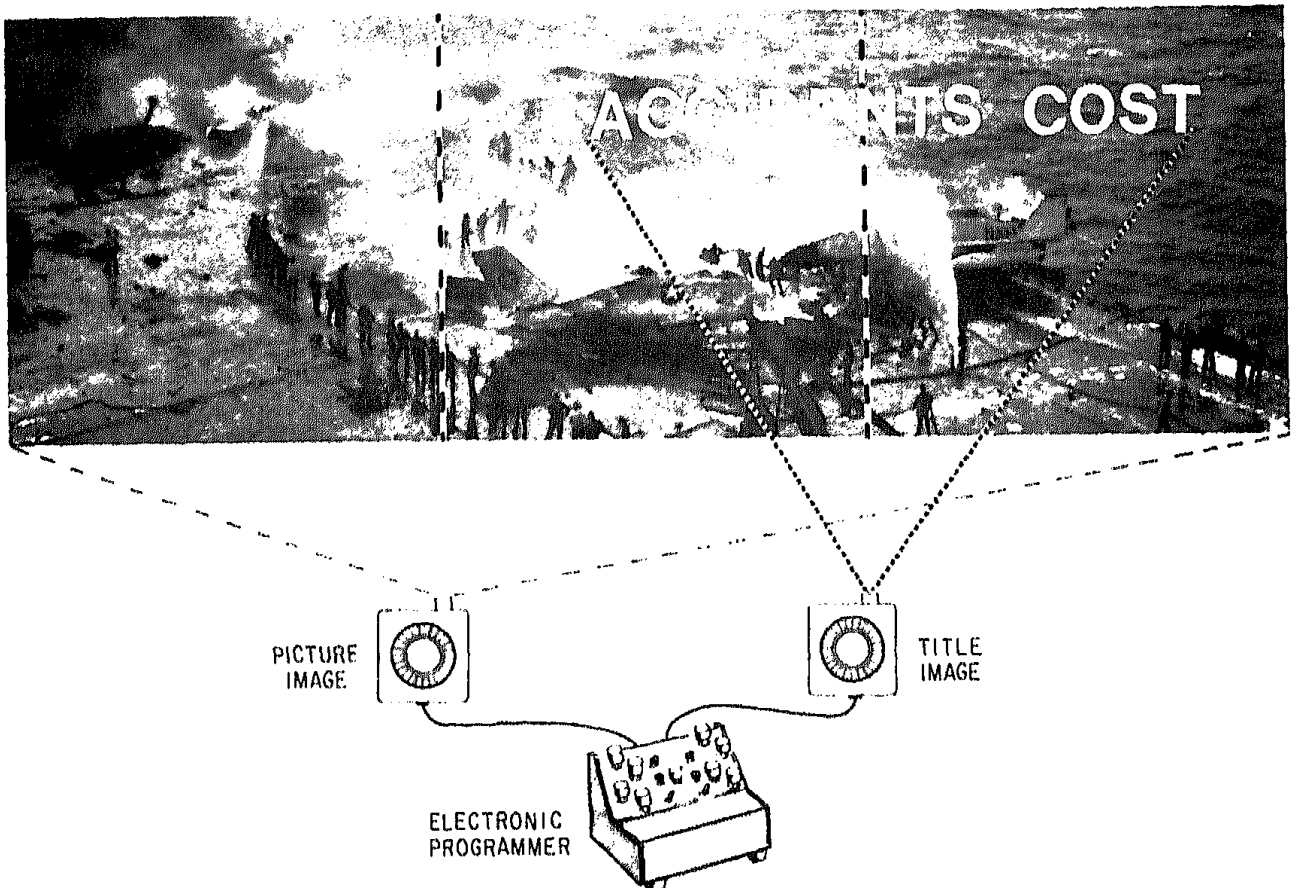
The two basic methods of doing superimposition are done by:

● Having the lamps of two (or more) projectors on at the same time and the images projected in careful alignment.

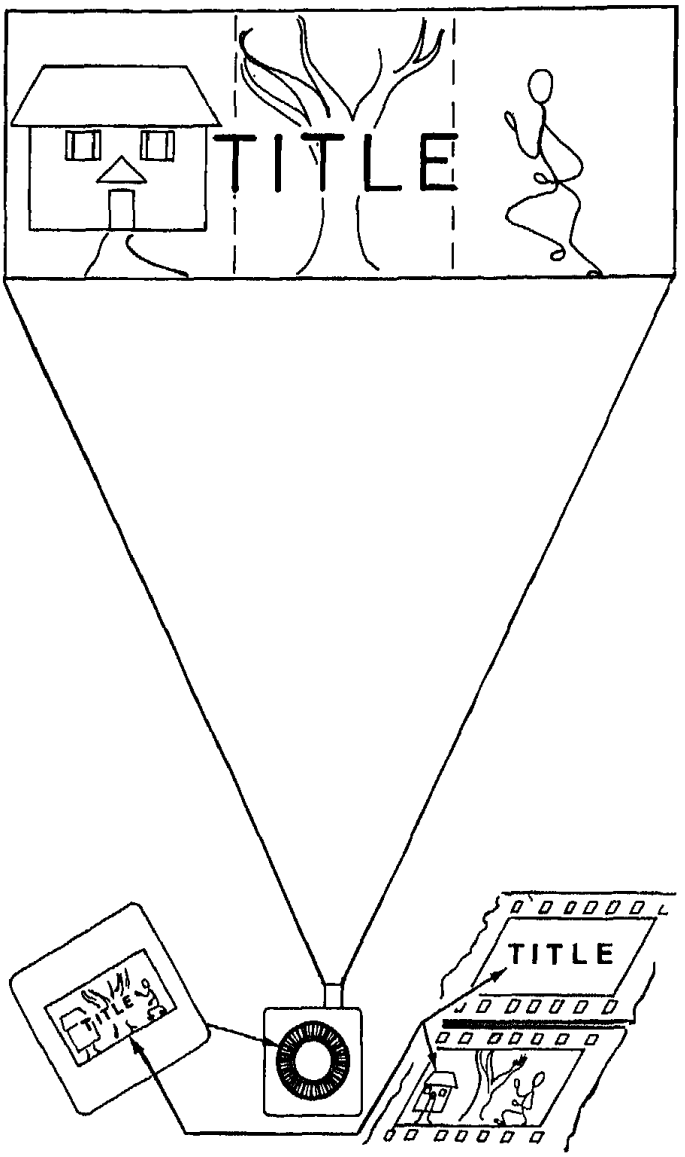
● Using a single slide—either one that was

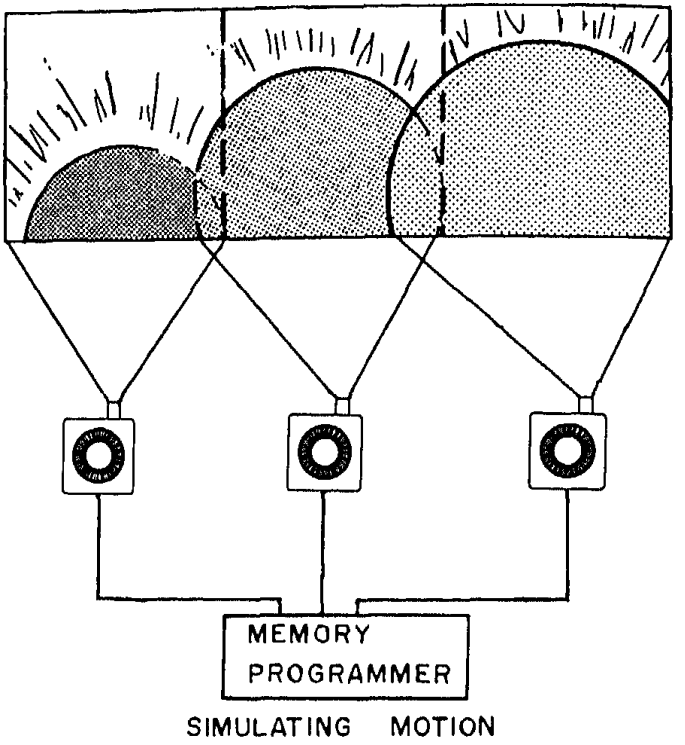
*Courtesy Arion Corp.*

**Multi-image programmable dissolve control.**



films mounted together in one slide mount.




## Using Motion Pictures

The *novice* to multi-image production often asks, "When should I use motion pictures in my multi-image production?" The answer—avoid using them unless it is NECESSARY to have visual motion which can't be created through the use of still photography. This is not to say, however, that mopics don't have a place in multi-image—they certainly do—but not necessarily for the *inexperienced* producer. Many of the very best multi-image productions use no mopic footage at all, so be assured that including movies is not necessarily the sign of a multi-image production "professional."

However, when the multi-image presentation which has filled the screen with still images all at once comes to life with motion, a dramatic effect is usually created.

If you decide to incorporate mopics into your multi-images, you should have supporting stills of the movie subjects shot at the same time the mopic footage is being made. This will provide you with material for some excellent effects. For example, a still image on the screen can jump into action or the action of the movie image can be frozen with a still image. Or still visuals of the motion picture subject can be shown around the

## Effective Use of Image Area

When working with the three screen/image area format, it is not necessary to always use the entire viewing area. In fact, it may often be better to use only part of the total area. One of the ways multi-image can be used to simulate motion is to keep the viewer's eyes moving. By proper placement, sequencing, and timing of the images on the screen, you can establish rhythms and relationships between the visuals. Thus, the multi-image presentation does not always need motion pictures to create the feeling of motion.

outside of the screen while the moving images are projected center screen.

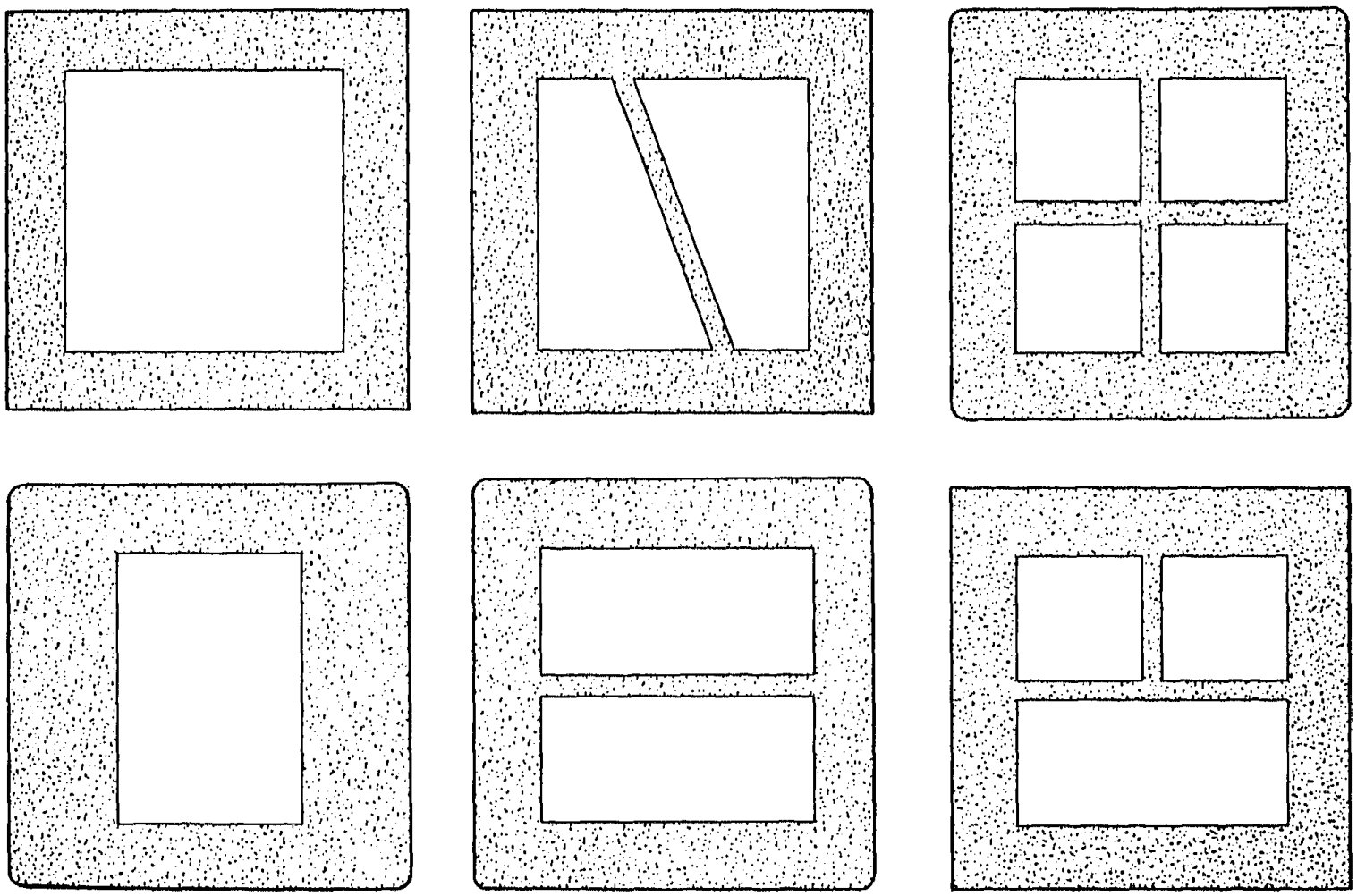
> Planning, scriptwriting, etc., for multi-image are basically the same as required for any other AV presentation.

### Making the Visuals

As important as the audio is to a multi-image production, there can be no multi-image show without the visuals, and the quality of these visuals will make or break the show. No amount of showmanship, superb narration, or flashy sequencing of the image will result in an effective presentation if the visuals are dull, lifeless, and of poor quality. Therefore, you must devote a substantial part of your time to producing and/or selecting the visuals—both still and motion picture.

VISUAL FORMAT.—Most multi-image shows rely heavily on projected 35mm slides. However, 35mm is not the only multi-image format.

Slides can be produced in a number of formats: they can range from the very small Kodak 110 format through 40mm × 40mm superslides—and they can all be mounted in 2 × 2-inch slide mounts. The 2 × 2-inch slide mount image area need not be standard 35mm (34mm × 25mm), or the 110 or 40mm format. The format or shape possibilities of the image area are almost unlimited. Since most of the multi-image shows produced in our Navy will consist primarily of images mounted in 2 × 2-inch slide mounts, we shall, primarily, limit our study of producing the visuals accordingly.



**Examples of the many 2 × 2-inch plastic slide mounts available for multi-image productions.**

age, you should realize that there are dimensions to consider. One is the e area formed on the film in the other is the *visible* image area within onal slide mount. This second set of s smaller than the first.

amiliar with the term "aspect ratio." of AV, it refers to the ratio of two of a visual area—the visual's *width eight*. In 35mm photography, the s actually 36.5mm wide and 24mm ver, the aperture area of a standard 2-inch) slide mount is only 34mm by is allows for inaccuracies when e slide.) Both of these aspect ratios to 2 or 3:2. This is the result of two dimensions by the common 12 and rounding off.

e:

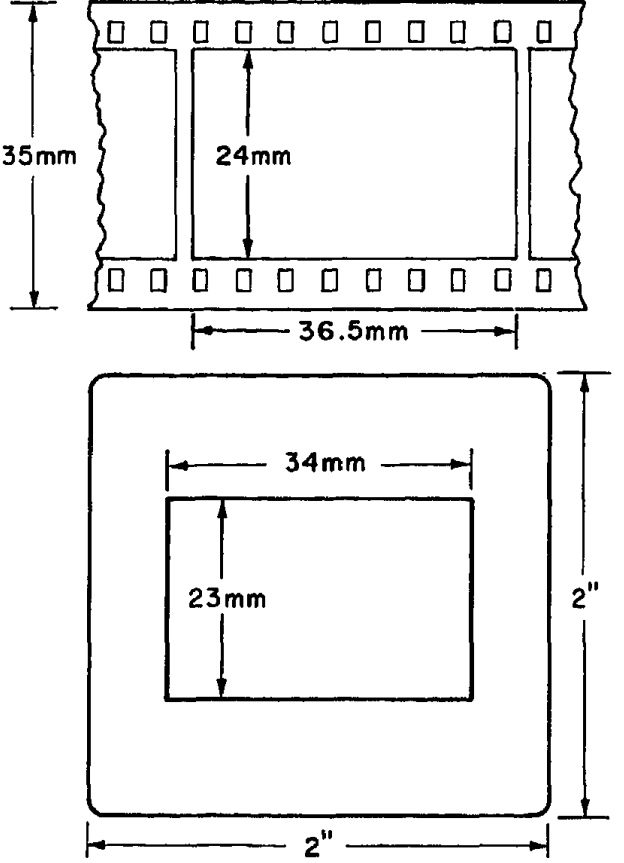
÷ 12 = 3.ØØY
÷ 12 = 2
} or 3:2

÷ 12 = 2.833
÷ 12 = 1.916
} or 3:2

e the comparison of aspect ratios naller dimension can equal unity; i.e., e, the standard 35mm slide format can be expressed as 1.5:1 instead of = 3 ÷ 2 = 1.5:1.

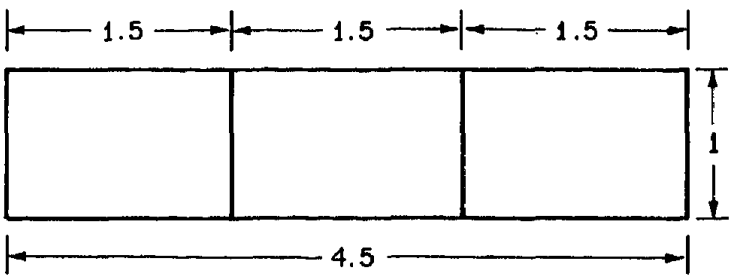
l single slide aspect ratio is ideal for nto our 3:1 ratio screen because, when ne three single slide 1.5:1 ratios equal .5:1 aspect ratio. Of course, wider s can be used adding image areas to at bring the aspect ratio to 4:1, 5:1, e our peripheral vision is only about those members of the audience close area in excess of about a 3:1 ratio to physically turn their heads to see nage area.

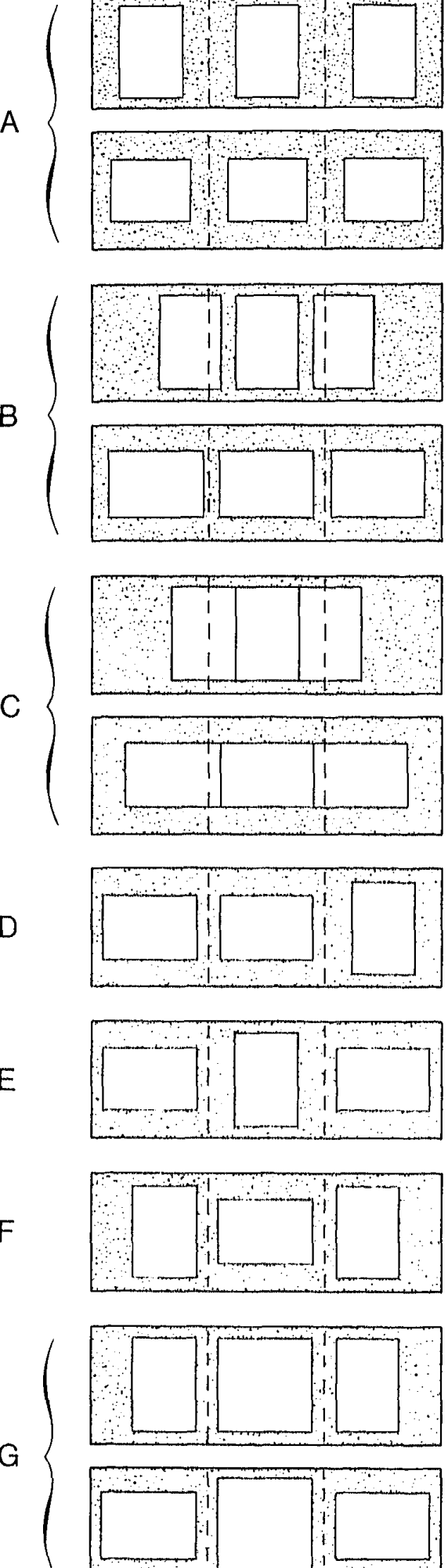
e viewing screen format will dictate als are presented, it should be decided




on during the planning stages of production. If the presentation is to be given at a fixed site, such as the station theater, then the physical space of that site will be a primary factor in determining the screen dimensions or aspect ratio. However, if the show is to be portable, other factors which affect portability must be considered as well as the possible physical layout of all foreseen presentation or staging sets.

In any case, it is *probably* best to keep the screen aspect ratio limited to not greater than 4.5:1. When the aspect ratio is kept to 4.5:1, and when the screen is far enough away from the audience, it will be within their critical visual span—which is about 75 degrees.






A screen with a 4.5:1 ratio, has, in effect, three separate 1.5:1 image areas. The following examples are only a few of the many possible simultaneous image configurations.

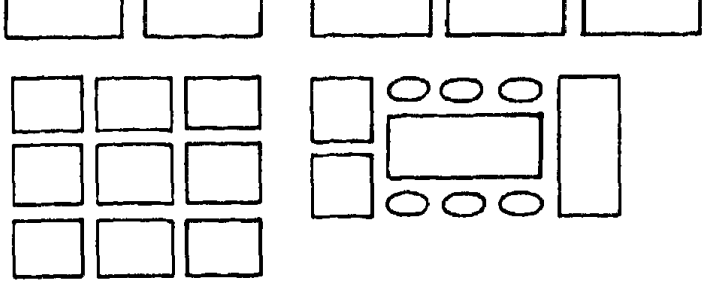
Through the use of special offset aperture slide mounts, the spaces between images in example A may be reduced as shown in example B or even eliminated as in C. This makes a three image panoramic possible.

Within the area of the 4.5:1 screen aspect ratio, the three side-by-side images can be used to organize the visual content. Example D, for instance, uses two horizontal visuals with formal similarity to show or establish visual contrast with the one vertical image. The visual arrangement of E is useful for focusing audience attention on the center vertical image, just as F uses outside vertical images to focus attention on the central horizontal visual. The widely spaced visuals in A can be used to present three separate, contrasting, or conflicting concepts, while the three closely spaced visuals in B show closely related concepts, etc. By using the 40mm superslide format shown in G, you add emphasis to the central image because the "super" image will overpower the adjacent smaller images—that is if the smaller images are not so visually powerful that they detract from the central "super" image.

Also to be considered when you are making the visuals is subject orientation; i.e., vertical subjects *usually* are best presented in a vertical visual—*usually*, but not always. And, likewise, horizontal subjects usually need horizontal composition.

The audience's eye movement across the images on the screen should be smooth unless a deliberate disruption is desired for a particular effect. Remember your study about picture layout in chapter 3 of module 2? Well—the same basic principles apply here. And don't forget—our sailors have been conditioned to examine a visual field from left to right, top to bottom, upper left to lower right.

The visuals for a multi-image show need not be side by side as shown in the previous examples.



To the contrary, the visuals can be projected in matrices such as those examples shown here.

Due to the fact that slide matrices use rather small images they tend to lack "big" image impact. However, by their nature, they can present more images for the audience to view and think about at one time, thus they can create "action" or increased viewer participation. When such matrices, especially complicated ones, are used they generally require more than three projectors.

There may be times in your multi-image work when B&W slides are most appropriate. For example, if you are doing a multi-image show on the history of the Pensacola Naval Air Station, it wouldn't be appropriate to use color slides of the very early years of the air station because only B&W photography was done then. In this case, those early photographs and documents should be copied in B&W and B&W transparencies produced.

Generally speaking, the producer of multi-image has available three types of slide mounts: cardboard, plastic, and glass.

*It's multi-image show time. Sam Sailor is proudly loading his "masterpiece" multi-image slide trays full of cardboard mounted slides onto the projectors. Good ole Sam is sure thankful to his crew back at the lab who did such a fine job of mounting his slides. one appears. USS Ship never looked so good. Appreciative "oohs and ahhs" rise from the sailors.*

*Advance to slide two ... wait a + = −?XXR#%& minute. It appears Sam's slide is stuck. + = −XXR#%&, not only is it stuck, it's crushed in the projector. Up with the lights!, sailors heckling, Admiral fuming, DH glaring, DO crawling under his seat. And Sam? He's left holding a ruined cardboard slide mount. The moral of the story ... AVOID cardboard mounts.*

Glass slide mounts are generally quite heavy as compared to cardboard and plastic and are very susceptible to breakage which can cause problems, especially when the show goes on the road.

The problems associated with cardboard and glass mounts are numerous. Plastic mounts, however, are clean and long lasting. They are easy to use, will not bend in the projector, are available with rounded or angular corners, move smoothly in and out of the projector, and are available in a variety of weights, thicknesses, and aperture designs or openings.

## PROGRAMMING

Programming, as it equates to multi-image, means "automating." When you program a multi-image AV production, you are, in fact, equipping it to run automatically; or at least semiautomatically.

### Programmer

In order to automate or program your multi-image presentation, you need a programmer. A programmer is a device used to automate two or more things. Electronic memory

programmers are the most advanced type available.

Memory programmers are actually microprocessors. They "store" programming information. Not only do they store information, but the information "fed" into a memory programmer can be changed by simply pressing a few buttons.

An entire show may be stored or presented with the programming coming directly from the programmer's memory banks. However, a loss of electrical power during the programming process or the presentation causes "electronic amnesia." Therefore, the programmer's memory banks are not desirable for the permanent storage of programmed information or for presenting the show. The information programmed into the programmer, in the language of computers, must be "dumped"; i.e., transferred onto either an audiotape or a high-quality computer data tape. Some programmers have, as an integral part, a tape recording or dumping capability.

The resulting computer data tape is unrelated to the audiotape or sound track tape. The data tape's function is to store the programmed data. It is used to re-enter the programming back into the programmer's memory banks for use during the presentation.

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*The foregoing information on multi-image productions has been general in nature. Its purpose was to provide you with basic information on multi-image and to get you thinking multi-image.*

*Before you actually engage in multi-image production, it is suggested that you undertake a thorough study of the subject. Several excellent books on the subject are available. One of the best—and one that should currently be in your lab's tech library is Kodak's Publication S-12, images, images, images.*

*In addition,* Eastman Kodak Company *offers several AV workshops in multi-image production.*

*Courtesy Arion Corp.*

*Courtesy Audiotronics.*

**Multi-image programmer with dissolve control and built-in sync tape recorder.**

*Write* Eastman Kodak Company, *343 State Street, Rochester, NY 14650 for more information.*

The Chief of Naval Operations has established specific guidelines and limitations for the creation of AV productions. Before beginning any AV production, be sure to consult OPNAVINST 5290.1, *Navy Audiovisual Management and Operations Manual.*

## AUDIOVISUAL STAGING

Photographer's Mates are often required to assist with showing AV presentations. Whether or not a presentation goes smoothly depends, to a great extent, upon how well you or your workers accomplish the primary work of preparing the

Checklist jobs, such as scheduling the material to be shown and notifying people of the meeting, are usually no great problem. But this routine often neglects the matter of selecting appropriate apparatus and arranging it in the room to provide the most effective projection. This must be done well to make sure that the message reaches the audience, without interference by the projection process.

For good staging, follow these steps:

- Choose a room with adequate facilities.
- Select a seating plan and screen type.
- Determine loudspeaker location.
- Select the projector location and lens focal length.

available equipment and facilities which may be less than ideal by backtracking and modifying earlier decisions.

## ROOM FACILITIES

*Where the "ideal" room is not available, modifying existing conditions will improve a "possible" room.*

The room should be large enough for the greatest number of viewers expected. Large auditoriums or meeting rooms with folding chairs need 5 to 6 square feet of floor space per person within the *good viewing area*. Conference rooms or classrooms with fixed seating require about twice that area—10 to 12 square feet per viewer within the good viewing area.

For daytime projection in rooms with outside windows, temporary opaque drapes, portable chalkboards, or other makeshift devices to shield light from the screen may be used if darkening is inadequate. Light shields may be placed either at the screen or to block general room lighting coming in a window. For some specific purposes, a permanent shadow box around a screen may be desirable.

Special light control may not be needed for the extra-bright images obtainable with small screens (found in study carrels), or with high-gain screens.

Light sources that provide some illumination during projection, but not directly on the screen, help maintain a social atmosphere and permit note-taking. During projection the screen image highlights should be brighter than any other surface within the viewer's field of view. "Hot spots" caused by the glare from bare bulbs, reflections from shiny surfaces, or gaps in window covering should be eliminated.

Preferably, room lights should be controllable from a point near either the projector or the speaker's stand. Or, arrangements may be made for someone to turn lights off *as soon as an image appears on the screen*. The electrical outlet for the projector must remain "live" when room lights are turned off.

The ventilation should be independent of the room-darkening devices, the smoking lamp should be out, and a generous supply of fresh air should be available.

You can check for reverberations by a smart clap of the hands. A sharp, ringing echo indicates too much reverberation for good intelligibility. A "live" room (with objectionable echoes) is improved acoustically when well filled with people. Any high-volume noises or clearly intelligible speech at any level coming from outside the room should be eliminated. Low-level background noise does little or no harm.

### Audience Comfort

Regardless of how good a speaker is or how interesting the presentation may be, people in the audience will have difficulty paying attention unless they are comfortable.

Physical comfort is a necessity if the audience is to concentrate on a presentation. Nothing will distract a person more than a constant feeling that "It's too cold to think"; "It's so hot I can't concentrate"; "The room is so stuffy that I am drowsy"; "The light is so glaring it hurts my eyes"; "The light is so poor I can't see"; "It's so noisy I can't hear." The members of the audience may not express these sentiments, but they will certainly discuss them among themselves. These are legitimate complaints that deserve attention. The comfort of the people who attend the presentation should be considered and steps taken to make them more comfortable wherever and whenever possible.

## SCREENS

The screen is often the weakest link in a projection chain. A projection screen interrupts the light falling on it from the projector (or other sources) and diverts it to the viewer's eyes. The efficiency with which it does this affects image brightness, evenness of image brightness, color saturation, and contrast of the image.

In the use of multiple screens or screen images the adequacy of *each image or image area* should be considered individually. That is, ensure image size as well as brightness and legibility requirements are the same for each image.

### High-Gain Aluminum Screens

High-gain aluminum screens have thin sheets of specially grained aluminum foil laminated to

a slightly concave, noncollapsible lightweight frame. The screen reflects the projected light onto an area approximately 60 degrees wide by 30 degrees high. The reflected image is about six times brighter than that of other screens. Because of the special surface characteristics, this type of screen can be used in a normally lighted room. When properly positioned, the screen *rejects* room light by reflecting it away from the viewers, thereby retaining full contrast and color saturation in the viewing area.

### Matte Screens

Matte screens diffuse light evenly in all directions. Images on matte screens appear almost equally bright at any viewing angle. To avoid distortion caused by the viewing angle, however, viewers should be no more than about 30 degrees to the side of the projection axis, and not closer than two times the image height (2H) from the screen.

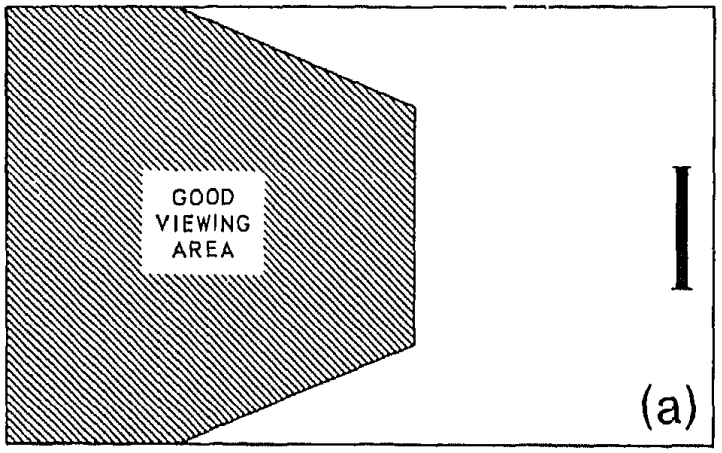
### Lenticular Screens

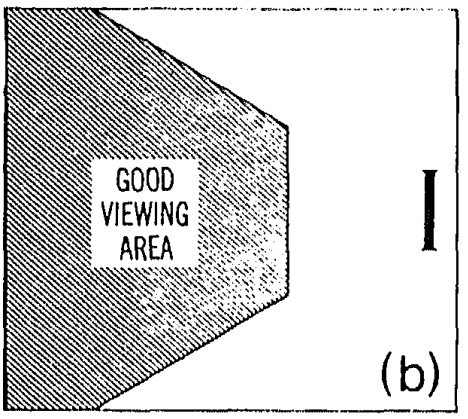
Lenticular screens have a regular pattern of stripes, ribs, rectangles, or diamond-shaped areas. The pattern is too small to be seen at viewing distances for which the screen is designated. The screen surface may appear to be enameled, pearlescent, granular metal, or smooth metal; and it may or may not have a coating over the reflective surface.

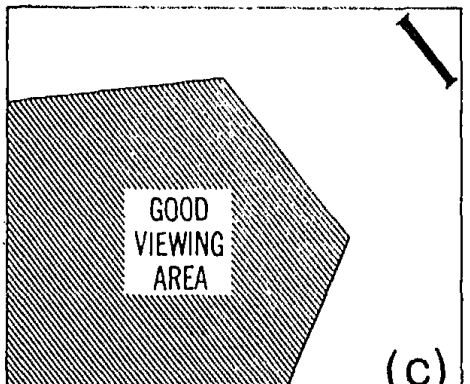
By controlling the shape of the reflecting surfaces, lenticular screens can reflect nearly all the light from the projector evenly over a fan-shaped area about 70 degrees wide and 20 degrees high. People seated farther to the sides of the screen than the 70-degree angle or above or below the 20-degree angle may not see an image—no image-forming light would be wasted outside the viewing area. Many lenticular screens provide an image three or four times as bright as a matte screen.

### Beaded Screens

Beaded screens are useful in long narrow rooms or other locations where most viewers are near the projector beam. They have white surfaces with embedded or attached small, clear glass beads. Most of the light reaching the beads is




**(a) In a long, narrow room (more than 1 1/2 times as long as wide), the best arrangement is usually that shown above. A beaded screen or other narrow-angle screen is suitable.**

**(b) In "squarish" rooms, more people will be able to see a satisfactory image if a matte or lenticular screen is chosen, because of the wider viewing angle it permits.**

**(c) In "squarish" rooms, more people can often sit in the good viewing area if projection is diagonal. A slightly larger screen may**

reflected toward its source. Thus, a beaded screen provides a very bright image for viewers seated near the projector beam. As a viewer moves away from the beam, the image brightness decreases. At about 22 degrees from the projector beam, the image brightness on a beaded screen will be about the same as that on a matte screen. Beyond this angle it will be less bright than on the matte screen.

Since nonimage or stray light is also reflected in the general direction from which it comes, stray light falling on a beaded screen from a viewer's position at the side of a room can be a major problem.

### Rear-Projection Screens

Rear-projected images have the same requirements for image brightness, size, and contrast as front-projected images. Rear projection has advantages in some situations, disadvantages in others.

A person or object in front (on the viewer side) of a rear-projection screen does not interfere with the projection beam. This makes rear projection useful when the projector must be unobstructive or hidden, as in displays. It permits close examination of the screen image. Rear projection may provide advantages in image contrast and color saturation in a lighted room.

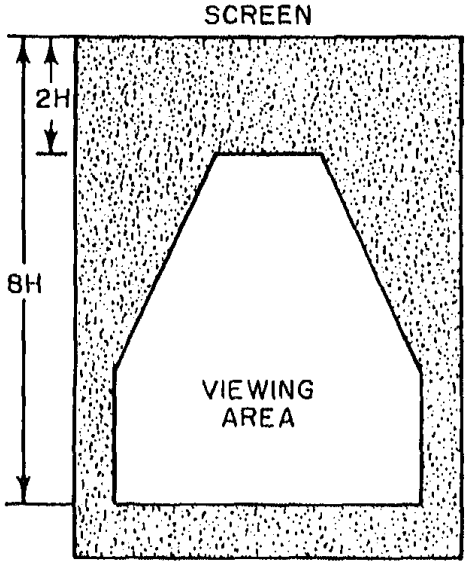
Rear projection may also have disadvantages. With conventional projection, the space over the heads of viewers is usually used for the projector beam. With rear projection, the projection beam is usually on the opposite side of the screen from the viewers. Consequently, space for the beam must be provided outside the viewing room (behind the screen). To reduce space requirements in rear projection, short focal length lenses are sometimes used. More commonly, mirrors are used to "fold" the projection beam. Either is likely to reduce image brightness and quality.

Another important consideration in rear-projection screens is the darkness of the screen as seen by reflected light. As with front projection, the highlight brightness of the image should be as bright or brighter than other areas within the viewer's peripheral vision.

If the image is to be viewed in a well-darkened room, there is no advantage in a dark-toned screen. If the image is to be large, a light-toned screen is usually preferable since it will absorb less image light than a dark-toned screen.

## VIEWABILITY

For viewability, members of the audience should be seated within the specified angles for the screen material being used and should not be seated closer to the screen than two times (2H), nor farther than eight times (8H), the height of the projected image. Minimum image height, for viewability, can be determined by dividing by 8 the distance from the screen to the rear of the back row of seats. For visual effect, it is sometimes desirable to project an image somewhat larger than viewability standards specify. To avoid obstruction of the screen image by the seated audience, the ceiling height should permit the bottom edge of the image to be located at least 4 feet above the floor.




## SPEAKER LOCATION

Sound quality is usually most satisfactory if the loudspeaker is near the screen and high enough to be *seen* by everyone. Low placement causes loss of intelligibility for all, except those on the front row.

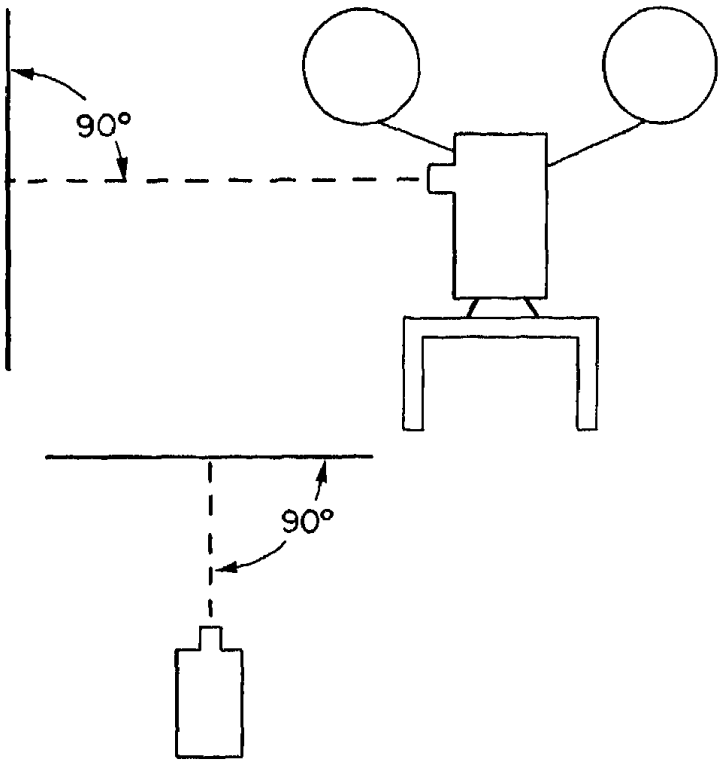
Where acoustics are poor, a corner location or extra speakers placed partway back in the room may help. Extra speakers should ordinarily be aimed toward the back of the room to avoid interference between separate units.

Proper tone-control adjustment can help greatly in any room. In an acoustically poor room, best intelligibility is usually achieved with the tone or balance control near maximum treble. These

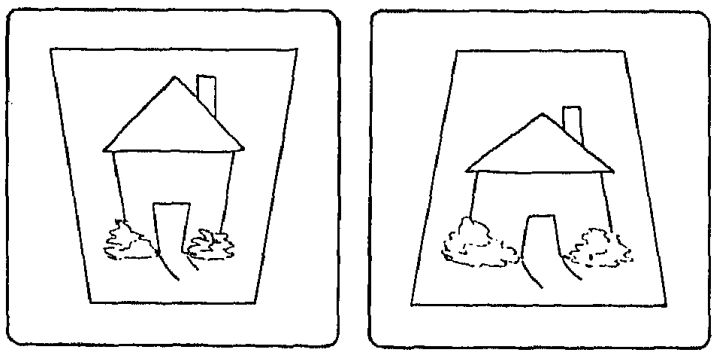
of music, but they do improve crispness of speech and reduce reverberation.

## PROJECTOR LOCATION

For an undistorted image, the projector lens should be on a line extended at right angles, vertically and horizontally, from the center of the screen surface. Projectors should be high enough so that their beams will clear obstructions, such as the heads of viewers.




Strongly upward or downward projection angles will cause "keystoning" of the image unless the screen is tilted.



The distance from projector to screen is determined by the size of the area being projected, image size needed.

The following table shows projection distances (projector-gate-to-screen distances) for selected image sizes, formats, materials, and lens focal lengths. The factor in the right-hand column of the table permits you to find the desired projection distances or image dimensions not shown on the table by using these formulas:

$$\frac{\text{projector-gate-to-screen distance} - (2\text{x lens focal length})}{\text{factor}} = \text{larger dimension of image}$$

$$(\text{factor} \times \text{larger image dimension}) + (2\text{x lens focal length}) = \text{projector-gate-to-screen distance}$$

When making the above calculations, be sure to express image dimensions, projection distances, and lens focal lengths in the same units.

## IMAGE BRIGHTNESS

Brightness (the amount of image light the viewer sees) depends on the viewing angle; screen type; projector design; wattage, life rating, age of the lamp; character of the material being projected; image size; line voltage; and design and cleanliness of the optics. Lamp wattage alone gives little indication of image brightness; using it as a measure of image brightness is like rating an engine by its fuel consumption rather than the work it does. Image brightness needed is not usually an absolute value. It depends primarily on the brightness needed to override the nonimage brightness of the screen in order to give satisfactory image quality.

Nonimage brightness of a screen is the result of all the light falling on the screen other than that actually forming the image. High nonimage brightness makes it difficult to obtain good blacks or dark areas in the projected image. The principle sources of nonimage brightness are ceiling and exit lights in the room or incompletely darkened windows, doors, and skylights.

Light escaping from within the projector itself, as well as from improperly designed or dirty projection optics, also contributes to nonimage brightness. These projector sources of nonimage light are usually of little consequence in well-designed audiovisual equipment in good condition.

| Format and Type of Material | Lens Focal Length in. | Lens Focal Length mm | DESIRED IMAGE SIZE (inches) 26 3/4 x 40 | 33 1/2 x 50 | 40 x 60 | 47 x 70 | 64 x 96 | (meters) 0.67 x 1 | 1.205 x 1.8 | Factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Projector Gate-to-Screen Distance (feet—nearest 1/2 foot) | | | | | (meters) | | |
| 2:3 ratio | | | | | | | | | | |
| 2 x 2 slides (135) | 2 1/2 | 65 | 6 1/2 | 8 | 9 1/2 | 11 1/2 | 15 1/2 | 2.0 | 3.6 | 1.9 |
| | 3 | 78 | 8 | 10 | 11 1/2 | 13 1/2 | 18 1/2 | 2.4 | 4.3 | 2.3 |
| | 4 | 102 | 10 1/2 | 13 | 15 1/2 | 18 | 24 1/2 | 3.2 | 5.6 | 3.0 |
| | 5 | 126 | 13 | 16 1/2 | 19 1/2 | 22 1/2 | 30 1/2 | 3.9 | 6.9 | 3.0 |
| | 6 | 152 | 16 | 19 1/2 | 23 1/2 | 27 | 36 1/2 | 4.8 | 8.3 | 4.5 |
| | 7 | 177 | 18 1/2 | 23 | 27 | 31 1/2 | 43 | 5.5 | 9.7 | 5.2 |
| | 9 | 230 | 24 | 29 1/2 | 35 | 40 1/2 | 55 | 7.1 | 12.5 | 6.7 |
| | 11 | 280 | 29 | 36 | 42 1/2 | 49 1/2 | 67 | 8.7 | 15.3 | 8.2 |
| 3:4 ratio | | | 30 x 40 | 37 1/2 x 50 | 45 x 60 | 52 1/2 x 70 | 72 x 96 | .75 x 1 | 1.35 x 1.8 | |
| 16mm motion pictures | 1 1/2 | 38 | 13 1/2 | 16 1/2 | 20 | 23 | 32 | 4.0 | 7.2 | 3.9 |
| | 1 5/8 | 41 | 14 1/2 | 18 | 21 1/2 | 25 | 34 1/2 | 4.4 | 7.8 | 4.3 |
| | 2 | 51 | 18 | 22 1/2 | 26 1/2 | 31 | 42 1/2 | 5.3 | 9.5 | 5.3 |
| | 2 1/2 | 63 | 22 1/2 | 28 | 33 1/2 | 39 | 53 | 6.7 | 12.0 | 6.6 |
| | 3 | 76 | 27 | 33 1/2 | 40 | 46 1/2 | 63 1/2 | 8.0 | 14.4 | 7.9 |
| | 4 | 102 | 36 | 44 1/2 | 53 1/2 | 62 | 85 | 10.7 | 19.2 | 10.5 |

## Image Not Bright Enough

The difficulty most often recognized is insufficient image brightness. One possibility for producing brighter and smaller images is to move the projector closer to the screen. Halving the distance will increase image brightness four times. However, this solution is satisfactory only when the material being projected is so designed that the information it contains can be discriminated satisfactorily in the smaller image size.

Screen characteristics can be used to obtain a brighter image. For example, high-gain aluminum screens permit a large image and, if properly aligned, the image will be at least six times as bright over the normal viewing area as an image of the same size projected on a regular matte screen.

If a visual test of the projection equipment does not demonstrate satisfactory brightness, check these common causes of reduced image brightness.

- When the equipment is operating, the line voltage at the projector plug should be within the range specified for the projector. A lamp rated at 115 volts produces 15 percent less light when the voltage drops from 115 to 110. At 104 volts, the loss is 30 percent. A lightweight extension cord can easily cause such a voltage drop.

- All equipment and materials in the optical system should be clean. The "optical" system includes reflectors or mirrors, lamp envelope, condensing lenses, heat-absorbing glass, cover glasses or glass pressure plates, the material being projected, the projection lens (all surfaces), and the screen itself.

- Old and darkened projection lamps produce less light. A lamp improperly centered or not locked in position may reduce brightness and cause uneven illumination.

- Unusually dense (dark) transparencies, of course, give less bright images. Some photographers consistently and intentionally produce dense transparencies, often because they project them regularly on a small screen with a powerful projector. In such a situation, properly exposed transparencies may look "washed out." Thus, the photographer may underexpose reversal film to obtain denser-than-normal transparencies which look good with his own equipment, but are too dense for standard projection.

screens may have become yellowed or darkened so that they do not perform well.

**Image Too Bright**

While the need for greater light output is usually recognized, the need for reducing light output can be as great and may be neglected. Overbright images may cause a dazzling effect and make flicker more apparent in motion pictures.

A good means of reducing light output is the substitution of lower-wattage lamps. It is usually possible to use a 300- or 500-watt lamp in a projector designed for a 750- or 1000-watt lamp, or use a longer life lamp. Reducing lamp voltage or using a lamp intended for a higher line voltage is a satisfactory way of reducing light output, up percent will reduce light output 30 or 40 percent, and prolong lamp life three to five times. Reducing the lamp voltage much more may result in an objectionable shift in color quality toward yellow and red and may shorten the life of tungsten-halogen lamps. Only the voltage to the lamp should be reduced; reducing the voltage to a projector motor or amplifier below its design voltage may cause overheating, unsatisfactory operation, and consequent damage.

Raising the general room illumination will often serve the same purpose as reducing image brightness, since it is the brightness ratio, rather than absolute image brightness, which is important. This is especially useful in reducing the dazzle effect of excess brightness in showing negative, or reverse-text, slides.

# CHAPTER 2

# PHOTOGRAPHIC QUALITY ASSURANCE

To assure success in the use of photographic materials in our Navy photo labs, a high standard of quality must be established. This quality standard should be aimed at producing negatives, transparencies, and prints of quality that will please the most demanding and critical customer. This standard must be flexible enough to allow improvement whenever possible. However, it must be inflexible in that no compromise with poor quality is permitted.

Once you have established your quality standard you can maintain it best through an exacting and practical method of quality assurance.

Quality assurance (QA) in photography has one purpose—to ensure that the photography produced is of constantly high quality, whether it be a negative, print, transparency, or any other form. The quality of these products is determined by three factors, each having many variables. These factors are human, chemical, and mechanical. The human factor includes those personnel involved in the photography, photographic development and/or printing, as well as those photographers who work directly in the quality assurance section of a photographic laboratory. Chemical factors include all the chemicals and solutions used to process and print original negatives, positives (viewing and intermediate), duplicate negatives, and prints. Mechanical factors include all equipment used to develop and/or print film and subsequent reproductions.

Quality assurance can be either subjective or objective. A subjective quality assurance program may be simply a set of standard high-quality negatives, prints, or transparencies, to which production results are visually compared. Although not a very reliable system, it can serve well aboard a small ship or at a small shore lab where only a few films are exposed and only a few prints are made daily. A subjective quality assurance program certainly is better than no program but it can't take the place of an objective program such as the one we shall discuss in this chapter.

Quality assurance can be applied to either a portion of the photographic system or the entire system. In quality assurance there are three basic steps:

- The quality standards for the process are specified.

- The process is evaluated to ensure that the standards of quality are being maintained.

- Any causes of poor or substandard quality are identified and eliminated from the photographic procedures.

Detailed quality assurance applied to the photographic process will assure the photographer of a better product if defects are spotted as early as possible. If a defective film holder is allowing light to fog the film, the defect should be discovered after the negative is processed (if not sooner). Certainly it would be a waste of time and material to make prints from such a negative if the photograph has to be reshot. In this chapter we explain some of the many quality assurance procedures which you can apply to improve the product.

Chemical and sensitometric means are used in determining if the standards of quality are being sustained. The production of high-quality photographic products requires control over all the factors which affect film or paper. Film exposure and processing are the most important of these factors. Negatives or transparencies which have not been uniformly and correctly exposed and processed will have density differences (contrast) which are not within acceptable limits. Such negatives or transparencies cannot be successfully printed. Correct exposure and processing of film have a direct and positive

Good-quality negatives and transparencies also help cut operating costs by reducing the number of retakes or reprints needed.

Quality requires that photographic products be used *exactly* as recommended by the manufacturer. Manufacturers of films, chemicals, and papers recommend specific film exposure, chemical mixing, replenishment, processing times and temperatures, agitation techniques, wash rates, and printing and drying requirements. To be sure that such recommendations are followed in your photo lab, the photographic process should be systematically monitored.

Any monitoring system for the photographic process requires the establishment of a *reference* or *standard* and comparison of daily production to the reference. By systematically comparing daily production to the reference, you can detect, identify, and correct errors in procedures.

*Visual* comparison of the reference with the daily production is very subjective and limited in its accuracy. Therefore, any photographic quality assurance system should be built around the science of sensitometry. In its broadest terms, sensitometry, as applied to the whole photographic process, includes methods of measurement, process control and data analysis. It deals with all parts of the photographic process from exposure of the film to viewing the final image—*and its goal is excellence.*

## SENSITOMETRY

In modules 2 and 3 of this rate training series the quality of the photographic product was judged only from the point of its visual aspects. As a further step you should have a knowledge of other controlled working methods and techniques which ensure photographic quality. Slipshod methods will occasionally produce good photographs, but as a photographer you should not be satisfied with "sometimes" results when there are techniques and equipment available to assure you of uniformly good photographic production every time.

This area of control, or sensitometry, is a method of putting certain photographic theories time, effort, and materials.

When sensitometry is employed in a carefully monitored photographic process, variations from the standard and recommended corrections are expressed in numbers and not in terms of personal opinion. Sensitometry provides a permanent record of the process and shows whether the system was in control when a given film or paper was processed. The accumulated data is helpful in determining the cause of poor quality, the exact amount of deviation from the normal is indicated, and when records are kept, your photographers will be more inclined to follow recommended procedures more closely.

The first requirement in photographic quality assurance is the establishment of a standard for good processing and the range or limits for quality that should not be exceeded. The standard is based on developing the same amount of film or paper density for a given amount of exposure. First we shall see how this is done in black and white processing.

Since it would be impossible to consistently judge whether densities were accurately reproduced by viewing your normal production products, special test or control strips are prepared, by accurately exposing the material with varying amounts of light. These test strips are developed in your process, and the resulting densities read by an accurate device similar to an exposure meter. To establish your standards several strips are made, processed, and the readings of their densities plotted on a graph. The plot of the data establishes your standard. Similar test strips processed at regular intervals then are compared with the standard to ensure that the processing is under control. This, basically, is sensitometry.

Another term used in conjunction with sensitometry is densitometry. Densitometry is an integral part of sensitometry, being so closely tied in with it that the two terms are often used together or interchangeably. Technically, however, there is a difference between them, which is:

- Sensitometry or measurement of photographic sensitivity is the science of determining the photographic characteristics of light-sensitive materials.

is the method by which data are obtained for sensitometry calculations.

Measurements of densities are done on a logarithmic scale. In other words each greater value is a multiple of the last. Much the way the aperture settings of a camera each are double or half of the next. In order to understand sensitometry, it is necessary to become somewhat acquainted with the mathematics of logarithms.

## Common Logarithms

There are definite mathematical relationships between the processes used in photography—and these relationships can be used to produce the maximum results needed. In quality assurance work, you will use logarithms in:

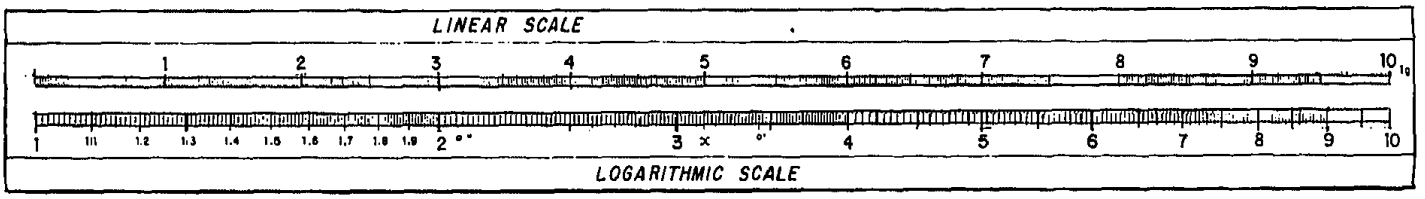
- Determining density
- Plotting characteristic curves
- Determining contrast
- Determining log E
- The use of densitometers
- The production of positive viewing transparencies

By means of logarithms, complex problems can be calculated with speed and accuracy. This is because you can add logarithms to achieve multiplication, subtract them to divide, and divide them to derive square roots. A logarithm is an exponent to a base number and is the power to which the base number, usually 10, must be raised to equal a given number. In photography we work with common logs, which are logs to a base 10. The base 10 is used because our numerical system is based on units of 10 and calculations can be made easier by the use of "powers of 10." For example, the logarithm of 100 is 2, because $10^2$ equals 10 times 10, or 100. The logarithm of 1000 is 3, because $10^3$ equals 10 times 10 times 10, or 1000.

One of the main uses of logarithms in photographic quality assurance is reducing characteristic curves of film to a manageable form. A characteristic curve indicates how increasing the exposure in a series of steps will affect the emulsion. Each step in the series represents a constant multiple of the value of the previous step. For example, exposure units could be in a series of steps such as 1, 10, 100, 1000, 10,000, 100,000, etc. Notice that this is only six steps, each step being a constant multiple of 10. Equal importance could not be given the first and last steps if the curve were plotted without logarithms. A major problem would be that the values would actually plot as a curve steep at one end and flat at the other. When plotted logarithmically, the curve becomes more uniform.

Unless you can use basic logarithms, we suggest that you review the chapter on logarithms in *Mathematics, Volume 1,* NAVEDTRA 10069 before proceeding with your study of photographic quality assurance.

In describing sensitometry we have to use several new terms and formulas. To start with, you should be familiar with the terms *transmission*, *opacity*, and *density*, or T, O, and D.



### Transmission

Most photographic materials, even clear film, do not transmit or pass all the light rays that are incident to them. Transmission is a measure of the light-passing ability of a film or other medium. When speaking of the transmission of a processed film, what is meant is the fraction or percentage of incident light that passes through the film. In a formula, transmission is denoted by a capital T. The formula for determination of transmission is:

$$T = \frac{\text{Amount of transmitted light}}{\text{Amount of incident light}}$$

The result will never be more than 1/1 or 1.00. For example, if 10 meter-candles (mc) of light are incident or falling on a film and 5 mc are passing through it, the transmission is: T = 5/10, or T = 0.50, or 50 percent. If 2 mc are transmitted, the formula will read T = 2/10, or 0.20, or T = 20 percent.

### Opacity

Opacity is a term given to the measure of the ability of the medium to absorb light. Since the two terms, transmission and opacity, are directly opposite in meaning, the figures used to indicate them are also directly opposite to each other. The opacity is indicated in a formula by the capital letter O and is the reciprocal of the transmission. The formula for opacity is given as:

$$O = \frac{\text{Amount of incident light}}{\text{Amount of transmitted light}}$$

You can see that it is the transmission formula turned upside down. Again, if a material has 10 mc of light falling on it and 5 mc are being transmitted, you can figure the opacity by the formula O = 10/5 or 2. Putting it a different way, opacity is the reciprocal of transmission, or O = 1/0.50 = 2. Or, if 2 mc are being transmitted, the formula is O = 1/0.20, or O = 10/2; in either case, the opacity is 5.

### Density

In formulas, density is indicated by the letter D, and is merely another way of expressing opacity, or the light-stopping ability of a medium. For the purpose of simplicity and evenness of progression, it is convenient to use the common logarithm of opacity for expressing the light-stopping ability.

It should be noted that of the three terms, density, opacity, and transmission, the one with which you will be most concerned is density. However, not one of the terms can be disassociated from the others, and each one of them is dependent on and directly related to both of the others. If the value of any one of these factors is known, with a little time spent in computations you can calculate the others. Many times you will be called on to do just this. You may measure the transmission of a film and then desire to know its density. Or conversely, you might measure the density and need to know the amount of transmission. While charts are available to give some conversions directly, it is well to be able to determine any of those figures.

## SENSITOMETERS AND DENSITOMETERS

Sensitometric-densitometric testing requires a method of comparing the amounts of density which result from emulsions that have been exposed exactly the same being processed for different times.

Sensitometers make controlled exposures which are suitable for sensitometric-densitometric testing procedures.

Densitometers measure densities.

### Sensitometers

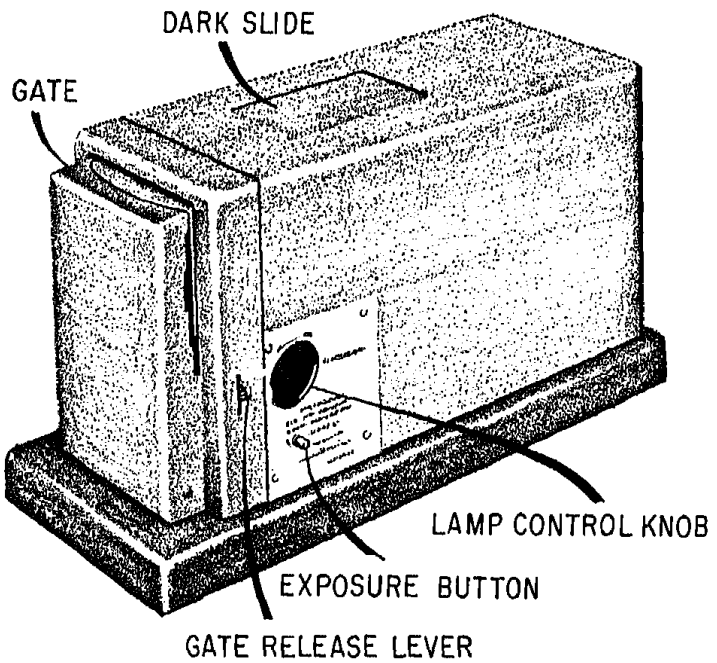
For sensitometric testing purposes you must have some way of exposing sensitized

sensitive material that has been properly exposed under measurable and reproducible conditions. For sensitometric test purposes, it is customary to expose a strip of film so that several exposures of varying amount are made on the same strip. This series of controlled exposures is made with a sensitometer.

Ideally a sensitometer should be designed so that you can do the following:

- Predetermine the total amount of exposure.
- Determine the difference in exposures given to various areas.
- Control the color quality of the light.
- Consistently reproduce or duplicate the same light conditions.
- Obtain a wide enough range of exposure to produce densities ranging from very light to dark.

Nearly any normal scene that might be photographed includes a wide range of brightness




**Sensitometer.**

measure. For the sake of simplicity, uniformity, and reproducibility in the application of sensitometry, the exposures produced by a sensitometer are arranged in a series of gradually increasing steps that correspond to the relative brightness values of a normal scene. These exposures are made on a length of film or paper of the same type you are processing. This sample is called a *sensitometric strip.*

EXPOSURE OF THE SENSITOMETRIC STRIP.—Photographic exposure is defined as the product of illumination and time. The two important parts of a sensitometer are its light source and the device for controlling the amount of light transmitted to the emulsion. Since total exposure is the result of the intensity of the illumination and the length of time it is allowed to act, it is obvious that the exposure may be varied by changing either the intensity or the time.

Light source lamps for a sensitometer must be carefully chosen, and their characteristics must be precisely known. The intensity of the light must also be known. It must be sufficient to make the time of exposure correspond closely with actual photographic practice, and it must remain constant over long periods of time. In addition to this, the color temperature must be known, and it must remain constant, and correspond closely to the quality of light likely to be used in practical photography. The reason for this is that the test strip should be exposed under conditions as close as possible to those which occur in practical use. There would be little purpose in knowing an emulsion's response characteristics under any other conditions. By basing sensitivity measurement on a known, practical basis, the film's response under practical conditions will be known, and various films may be compared to each other as to their spectral sensitivity and comparative speed. You know that emulsions often change in apparent sensitivity (speed) with a change in the spectral composition (color) of the exposing light.

Both the intensity and color quality of a lamp used in a sensitometer depend on the current flowing through the lamp's filament. It is necessary, therefore, to maintain the proper voltage at all times. Another factor in precision sensitometry is the change in both intensity and

a replacement lamp should be burned for a short time before using it for testing purposes. The old lamp should be discarded before any appreciable change occurs.

Incandescent lamps most suitable for use in sensitometers operate at a color temperature of about 3200 °K. The color temperature of sunlight is about 5400 °K. Therefore, you may need a filter to alter the color of the lamp so that it is equivalent to the spectral energy of sunlight.

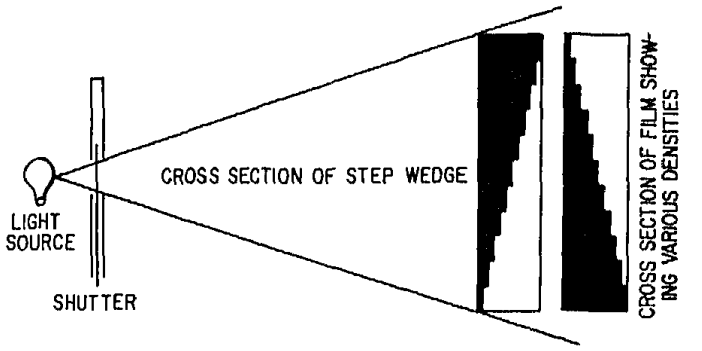
A sensitometer is used to produce a logarithmically graded series of exposures, the values of which are accurately known. These are generally arranged in steps from low to high exposure. Each new step represents twice the exposure of the last. A part of the strip is left unexposed so that the gross density of the material itself may be determined.

The device or method used to vary the amount of exposure must also meet certain requirements. It should be able to produce an exposure range that conforms closely to that found in actual practice, be accurate, be consistent, and have no significant effect on the color quality of the light.

Sensitometers are grouped into two classes. If the intensity of the light is changed while the time is the same for all the steps, the sensitometer is known as an intensity-scale instrument. If the time is varied while the intensity is kept constant, the instrument is a time-scale sensitometer.

Sensitometers in which the scale of exposures is produced by varying the intensity of the illumination on different parts of the emulsion are theoretically preferable to time-scale instruments because in actual practice, photographic materials are usually exposed to differences in illumination. Differences in time can also lead to errors due to reciprocity failure. Many types of sensitometers producing illumination scales have been designed, but those using light-absorbing filters, commonly known as step wedges, are the most widely used.

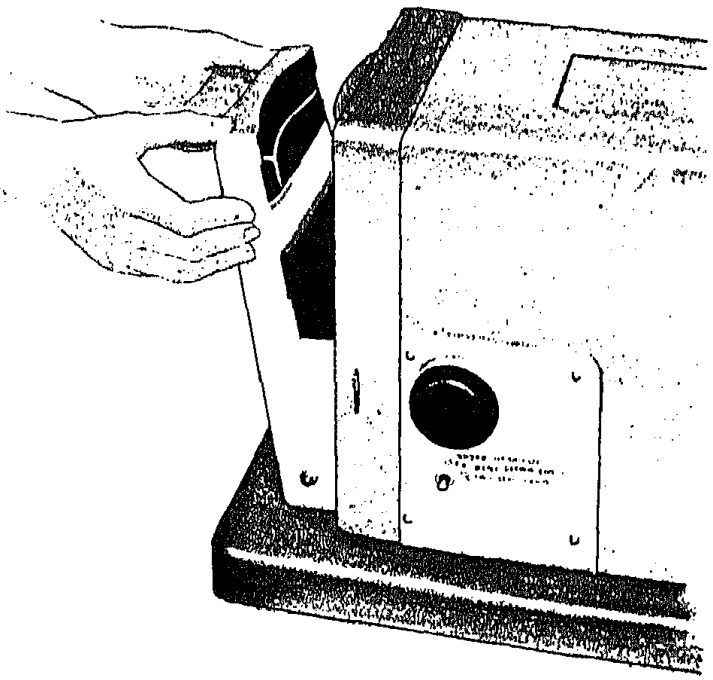
PROCESSING SENSITOMETRIC STRIPS.—Sensitometric strips are made by processing under controlled conditions of time, temperature, and agitation. This holds true whether the material is black and white or color, stills, motion pictures, or aerials, negative or positive material. Black and white control strips are usually made in the lab, while control strips




**Intensity-scale sensitometer.**

for color are obtained from the manufacturer of the material being processed.

After being exposed in the sensitometer, the sensitometric control strips are processed under the same conditions as the production film, and under controlled conditions of time, temperature, and agitation. In the case of machine processing the control or sensi-strip can be attached to either a roll of film or leader. In this event the strip goes through the processing machine tanks with the rest of the roll and receives the same processing. Remember that all steps in the processing of control strips and film are important, if the process is to maintain high standards and uniformity of



**Piacing a film strip in position in a sensitometer to make a sensitometric strip.**

carried out as carefully and as systematically as possible, with uniform times and handling techniques in each step from the exposure to the drying of the film.

### Densitometers

A densitometer is the instrument used for measuring and reading directly (in terms of density) the light-stopping ability of areas of negatives or prints. Certain types of densitometers read transmitted light, while others read reflected light. There are two main types of densitometers, the comparison-type meter and the direct reading-type meter. The direct reading-type densitometer is the one most used by Navy photographers.

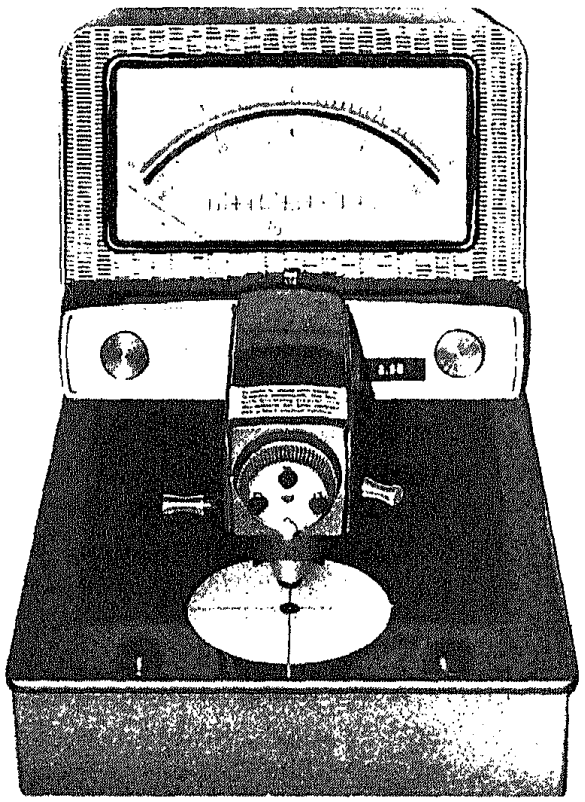
Direct reading densitometers use a photoelectric cell to electronically measure the light transmitted through a sample of the material. To use the meter, you place the material to be measured in the light beam between the source and the photocell. The density value is then read as a logarithmic scale, so you will be reading log values. And like sensitometers, densitometers have a calibrated light source.

You plot the density reading from the densitometer on graph paper.

## PLOTTING CHARACTERISTIC CURVES

The characteristic curve shows the relationship between exposure and the density resulting from the development processes. It is also called an H and D curve or a sensitometric curve.

For plotting a characteristic curve it is best to use graph paper ruled 20 units to the inch or 20 units per 1/2 inch. The horizontal axis of the graph is used to indicate log exposure, increasing from the left, and the vertical axis is labeled in density, increasing upward.



**Transmitted-light direct reading densitometer.**

*Courtesy COSAR Corporation*

**Combination transmission and reflection-type densitometer for color process monitoring.**

An illustration of a plotting sheet has been provided here with a graphic scale so that you may reproduce the plotting sheet to its original scale for use in your quality assurance program.

When labeling the graph paper remember that each 0.30 log density value represents a doubling value of density. Therefore, use 15 small divisions on the graph to equal the doubling of density and log exposure or .30 log exposure value. If the sensitometric strip is made with the **Eastman Kodak** #2 Step Wedge, as supplied with the **Eastman Kodak** Model 101 sensitometer, there is an increase of about 0.15 in density between each step or an increase of 50% density. The individual steps should be calibrated either by reading the step on a densitometer or, preferably, by having the Eastman Kodak Company supply a certificate of calibration for the step wedge supplied with the Model 101 sensitometer. The total density range of these steps is usually quite close to the 0.05-3.05 density specified, but the individual steps often vary about their nominal values. Therefore, to label the exposure steps on the graph let each 7.5 division equal each step of the sensitometric strip. Another advantage of having a calibrated step wedge is that the operation of the densitometer can be monitored with it to make sure that the instrument readings are not seriously in error.

Once the graph is labeled, use a densitometer and read the densities of the sensitometric strip and plot them on the graph to form a curve. Assume that the sensitometric strip has the following density readings:

| Step | Density |
|---|---|
| 1 | 0.18 |
| 2 | 0.19 |
| 3 | 0.21 |
| 4 | 0.26 |
| 5 | 0.32 |
| 6 | 0.40 |
| 7 | 0.49 |
| 8 | 0.59 |
| 9 | 0.70 |
| 10 | 0.79 |
| 11 | 0.90 |
| 12 | 0.99 |
| 13 | 1.10 |
| 14 | 1.20 |
| 15 | 1.30 |
| 16 | 1.40 |
| 17 | 1.50 |
| 18 | 1.60 |
| 19 | 1.70 |
| 20 | 1.78 |
| 21 | 1.82 |
| Gross fog | 0.12 |

To record these densities on the graph, start with the lowest density reading and place a dot at the convergence of that density on the vertical axis and step No. 1 of the log E axis. Do the same with the remaining steps 2 through 21 as illustrated on page 2-10. After plotting all the readings, connect the plotted points with a french curve and straightedge. Ensure that the curve is a smooth flowing line with no angles apparent.

Every graph should be labeled with all pertinent information, since all characteristic curves are similar in appearance. Information which is not recorded on the graph may be lost or forgotten, and the graph becomes useless.

## ANALYZING CHARACTERISTIC CURVES

Characteristic curves, also called H and D curves, D-log E curves, or response curves, are plots of density versus log exposure. If this curve is prepared on a standard form such as that shown on page 2-9, it is also referred to as a sensitometric chart. By analyzing a characteristic curve you can determine the effective speed of the emulsion, its gamma or its contrast index, and its latitude and useful exposure range. The foldout at the end of the chapter shows a typical characteristic curve with the various parts and their names.

The speed of the material being evaluated determines the position of the curve in relation

Material_____ Emulsion No._____ Date Exp._____ Date Dev._____

Sensitometer No._____ Neutral Density_____ Exp. Time_____ Illuminance_____

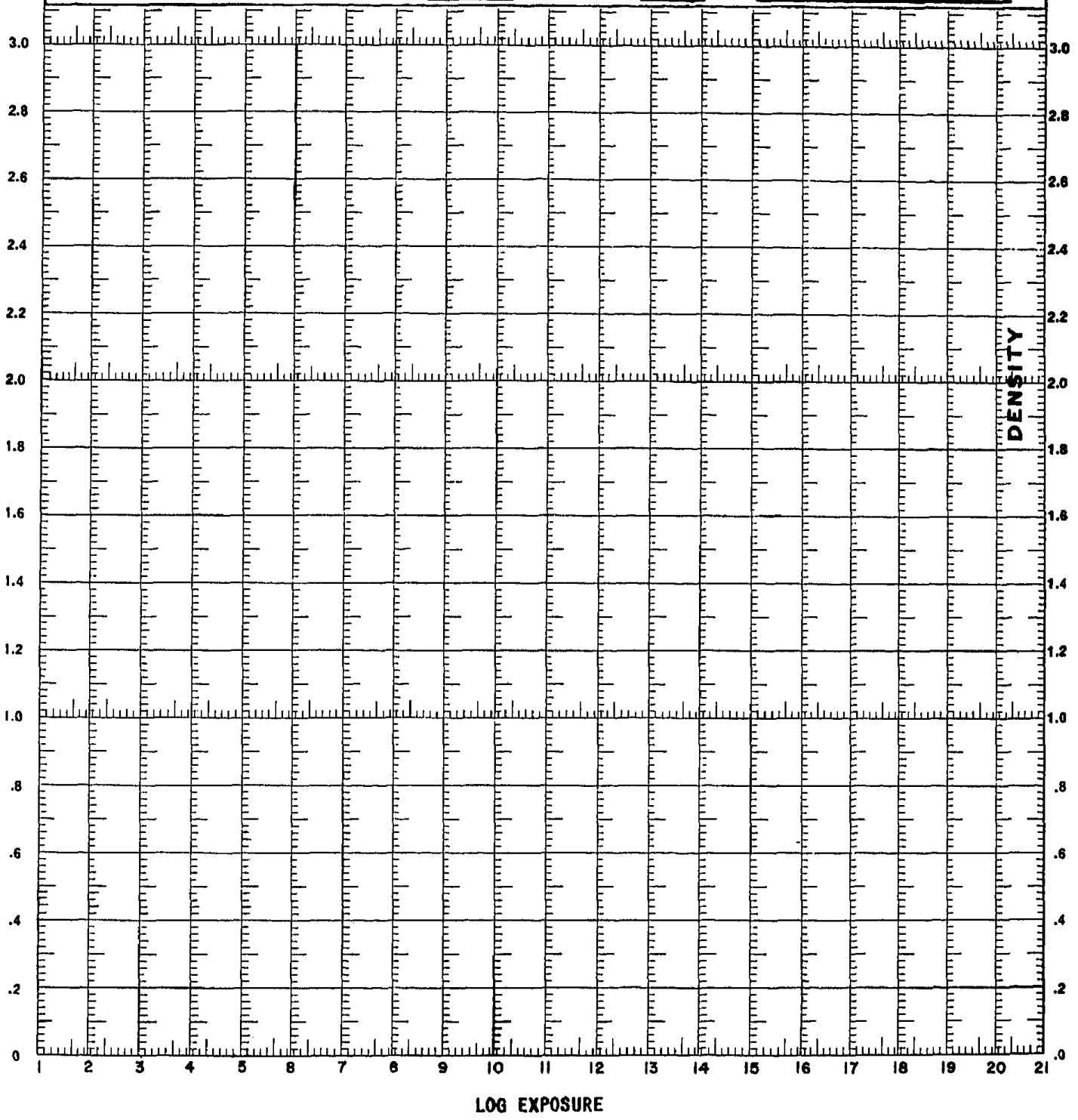
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

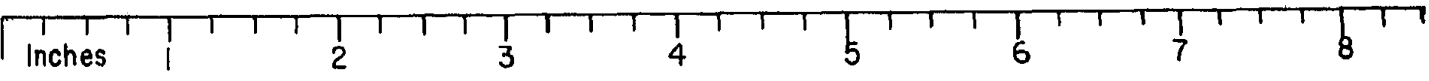
Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____



Material_____ Emulsion No._____ Date Exp._____ Date Dev._____

Sensitometer No._____ Neutral Density_____ Exp. Time_____ Illuminance_____

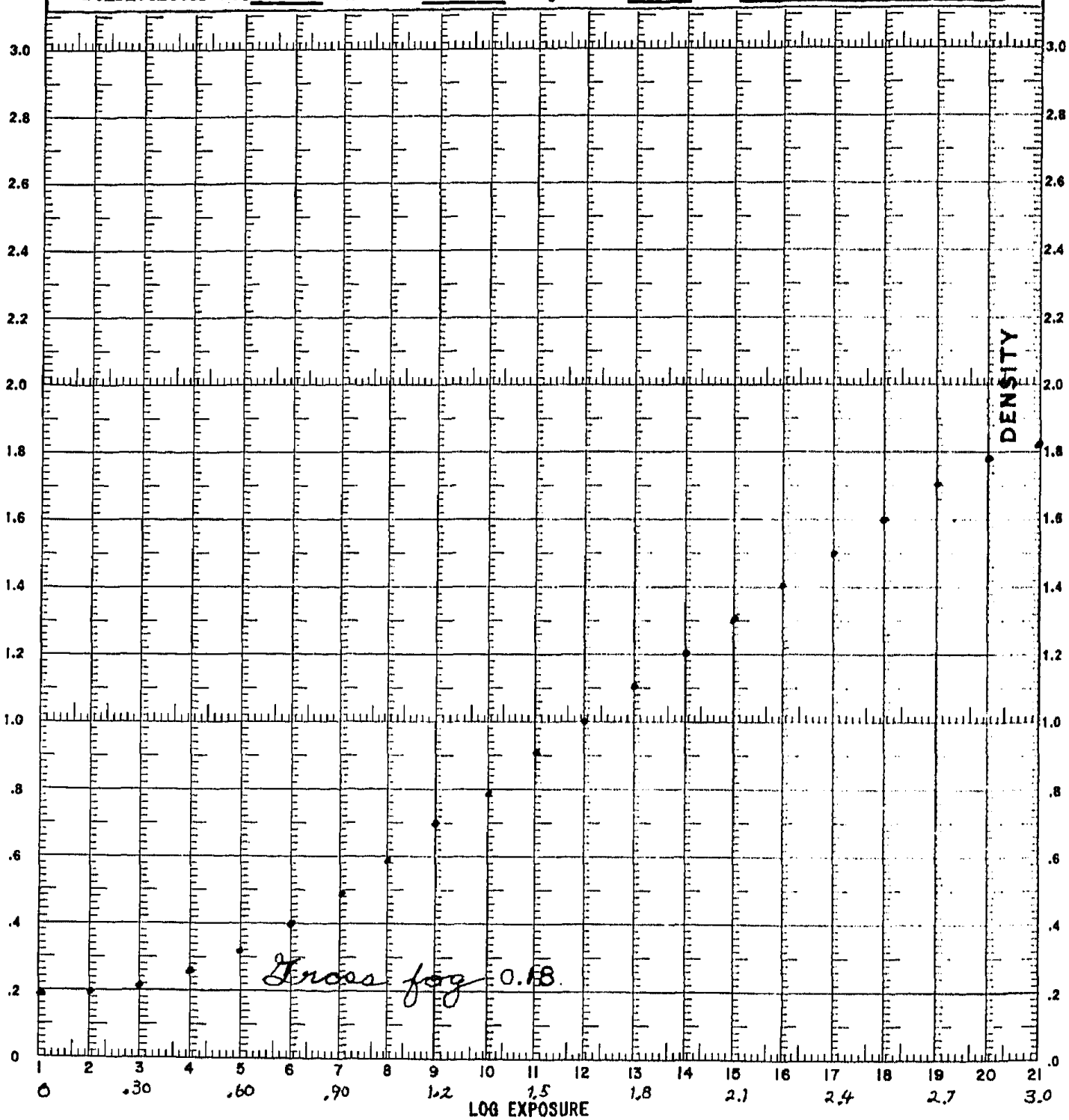
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____



Sensitometer No._____ Neutral Density_____ Exp. Time_____ Illuminance_____

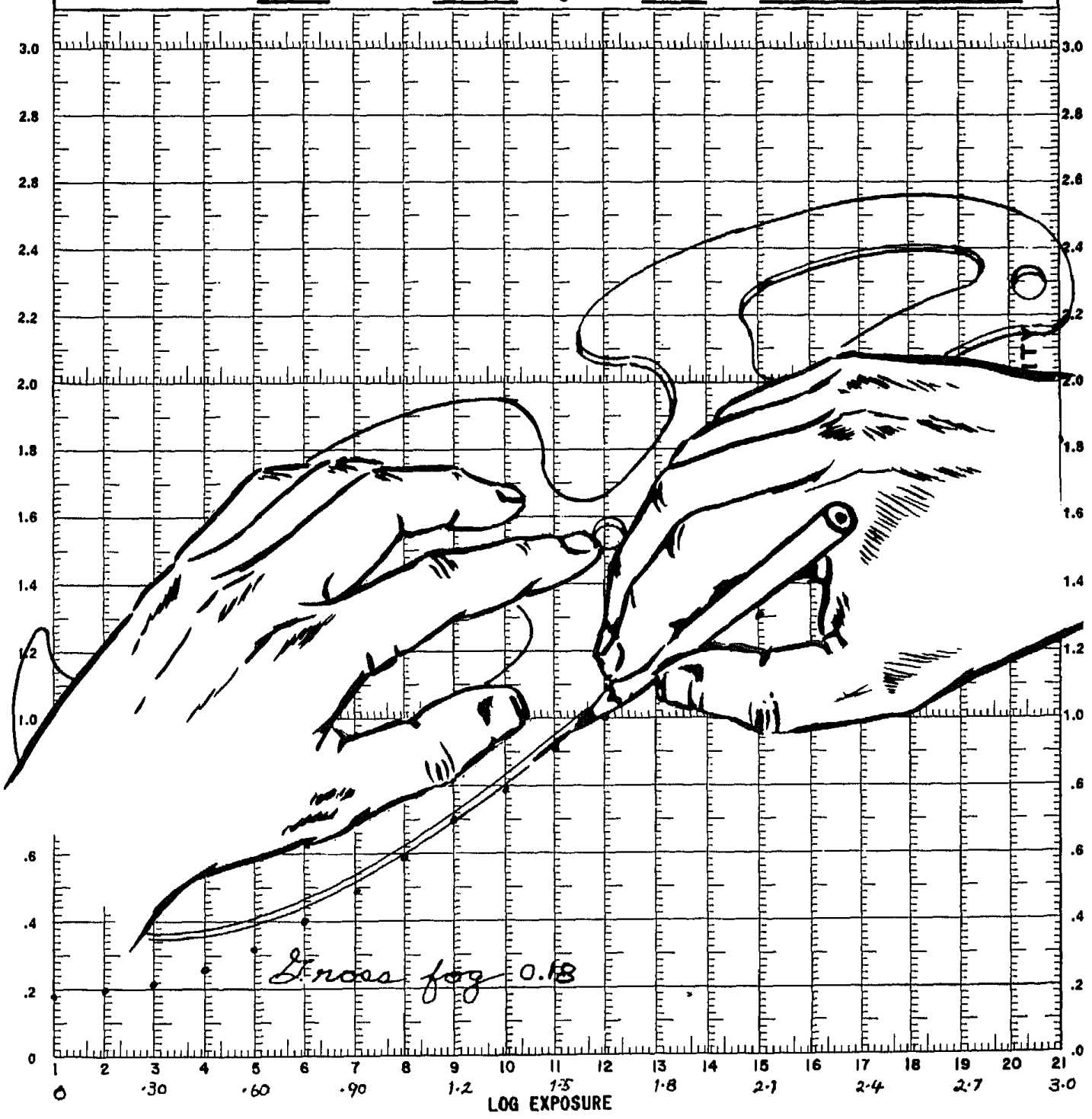
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____



Sensitometer No._____ Neutral Density_____ Exp. Time_____ Illuminance_____

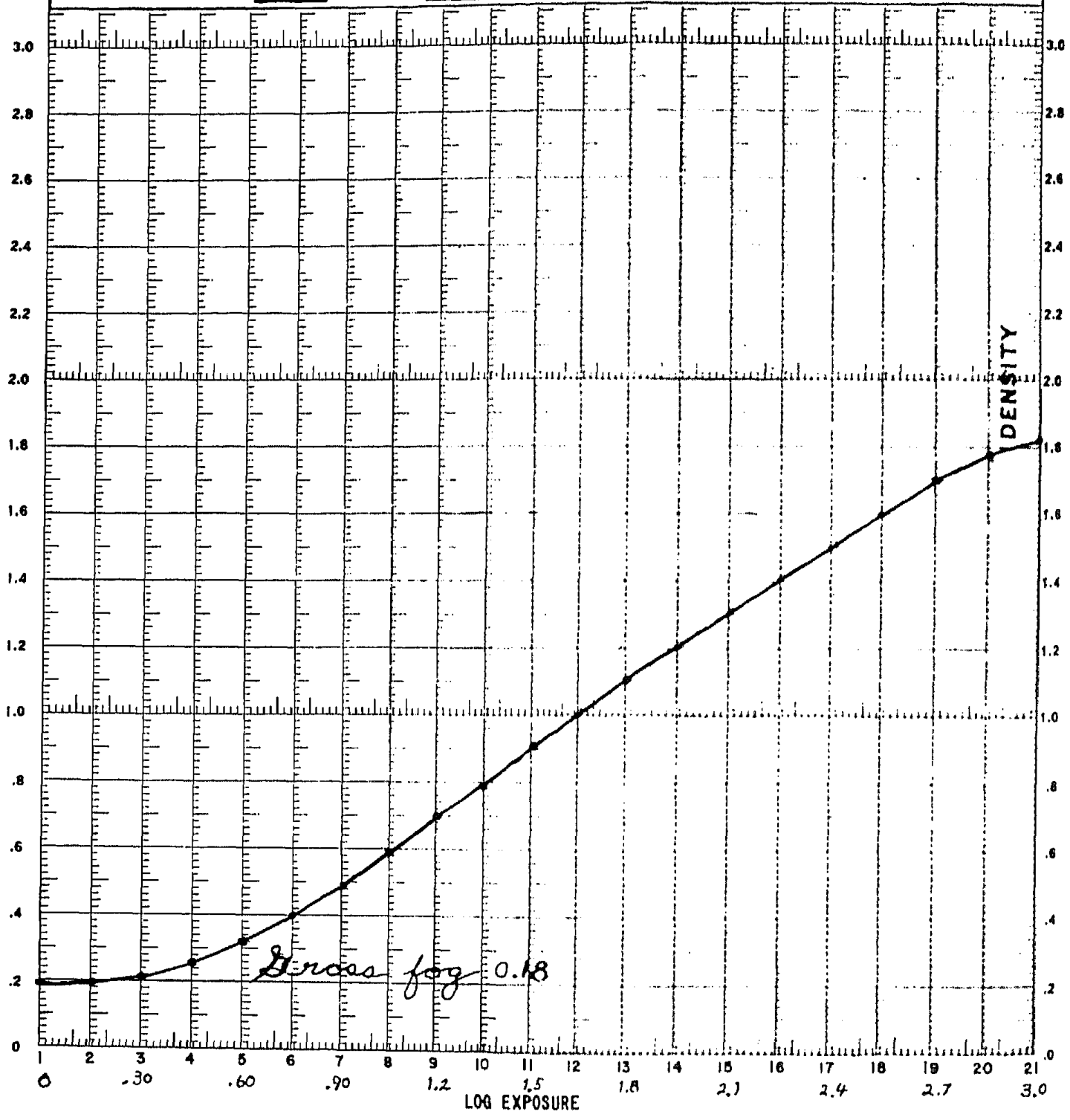
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____



length and slope of the straight line portion are the main variations to the shape of the curves. All densities on the straight line portion of the D-log E curve increase proportionally with an increase in development time. The slope or gradient of the straight line portion of the curve also increases as the development time is increased. That is, it gets steeper.

### Horizontal Axis

The horizontal axis represents the amount of exposure the material received.

### Vertical Axis

The vertical axis represents the amount of density created by each step of exposure. Since the densitometer readings are logarithmic, the numbers or the scale are, like the log exposure scale, in a direct progression, representing logarithmic values.

Notice in the illustration on page 2-12, that the first two steps show a slight and equal amount of density. This indicates that this area of the film has not been affected by the light, and the density is due not to exposure, but to the emulsion base and to the emulsion fog (gross fog) which are present to a certain extent in all emulsions. On the third step, a slight increase in density is shown. This is called the threshold and indicates the least amount of light that is required to produce a density which is perceptible. Exposures in this portion of the curve lack shadow detail.

### Toe Section

The threshold is the beginning of the toe portion of the curve. The toe is a concave, rising portion that gradually increases in density. This section is defined as a region of unequal rise, because the density does not increase equally for equal increases in exposure. Any subject tones exposed here will be reproduced with small, unequal density differences. These differences increase toward the right in the toe and satisfactory exposures can be made with the shadow portion of the subject falling not too far down in the toe area.

Farther to the right is a section of the curve which appears to approximate a straight line. (In many cases there is no well-defined straight line.) This part of the curve has a constant slope, and in addition, the gradient of the slope here is greater than in any other part of the curve. The straightness of this line portion indicates there is an equal increase in density for equal exposure increases. This is the most important part of the curve. Exposures made so that the subject tones fall on the straight line will produce constant density differences.

### Inertia

If the straight line portion of the characteristic curve is extended downward to intersect the log E axis, the point of intersection is called the "inertia" or inertia point.

### Shoulder

The upper portion of the curve is a convex, curved line, gradually decreasing in slope, called the shoulder. This again is an area where equal changes in exposure do not produce equal differences in density. Tones of the subject falling very far up in this area will be blocked, that is, reproduced with densities too heavy for printing or maximum detail. For normal exposures, bright highlight tones of the subject tend to be reproduced in the shoulder portion of the curve.

### Exposure

Although sensitometry is a tool of the lab technician, it also is significant to the photographer. Let's take a minute to see how it applies to exposing film. If a uniformly lighted gray scale card is photographed, there is a single exposure corresponding to a single point somewhere on the log E axis. If the light on this surface is increased and another photograph made (maintaining the same camera settings), the exposure and the log E will also have been increased. This causes a shift to the right on the log E axis. There should be a corresponding increase in density, and the two factors again should plot on the characteristic curve.

Extending this to a scene having a large number of reflectances or tones, it can be seen that the tonal differences in the subject, the lighting, and the camera settings determine the exposure received by the film. Since the differences in the tones in the subject determine the spacing of corresponding points on the log E axis, the points may all be shifted to the right or to the left by altering the level of illumination or changing the camera settings.

## Density Differences

The vertical axis represents the densities in the negative. It shows the way in which the tones of the subject are reproduced by the negative material. It is of minor importance whether the general density level is thin, moderate, or heavy. What does matter is the difference between tones. (Of course, it is important to consider the detail which can be seen in a negative and whether or not the highlights are blocked up.) This is what is meant in sensitometry by the term "density differences."

Density differences depend in part on the log E differences with which the process started. If the subject has many widely separated tones, large density differences are to be expected in the negative. Conversely, if the subject consists of tones all nearly alike, the negative can hardly be expected to contain much variation in tone.

It can be said that negative quality depends on density differences in the negative. These density differences must be related to the log E differences which produce them. That is, density differences in the negative must be considered in their relationship with the tones in the subject.

The density differences in a negative can be partially controlled by placing the exposures corresponding to the subject tones in the correct portion of the characteristic curve. This is done by the correct adjustment of the camera settings, provided that the range of tones in the subject is not too great.

between density differences and log E differences is obtained. In other words, it is simply the range of exposures covered by the straight line portion of the characteristic curve. The latitude of an emulsion, therefore, determines the brightness range of the subject which may be proportionally reproduced. Latitude may be expressed either as the difference in log E values between the extremities of the straight line, or as the exposure ratio between these same two points.

The latitude of negative materials varies according to the purpose for which they were designed—from 1:400 or more for a general purpose panchromatic film, to perhaps 1:20 or even less for process films. For any given emulsion, the latitude varies according to the contrast and becomes less as the contrast increases.

## Useful Exposure Range

The useful exposure range includes part of both extremities (toe and shoulder) as well as the straight line portion of the curve. The useful exposure range of a sensitized material is generally greater than its latitude, since it is often possible to use portions of the toe and shoulder regions of the curve without sacrifice in the quality of the tone reproduction.

The lower limit of the useful exposure range is the point on the characteristic curve at which the slope is 0.3 of the average slope for a log E range of 1.5. The upper limit of the range has not been fixed definitely but is generally taken to be at the point on the shoulder of the curve at which the fractional slope is also 0.3. In practice, many photographers use a much lower upper limit because of the high densities involved.

## Exposure Latitude

Exposure latitude is the allowable range of exposures for a given photographic emulsion, scene, and brightness range. A photographic emulsion will provide an acceptable negative at any exposure taken within the limits of its

the straight line portion of the film's characteristic curve. If the useful exposure range of the film is used, the exposure latitude of the film will be greater, since portions of the toe or shoulder may be included along with the straight line portion of the characteristic curve.

Normally, the lower the contrast of the scene and the faster the film, the greater is the exposure latitude.

Modern high speed B&W films have an overall exposure latitude of several stops for an average subject. However, color reversal and very slow B&W and color negative films have very little exposure latitude, regardless of the brightness range or scene contrast. Thus, the range of exposures lies within a very narrow limit (less than one-half to one stop).

## GAMMA

In technical terms, gamma (signified by the Greek letter $\gamma$) is a sensitometric quantity which indicates the slope or gradient of the straight line portion of the characteristic curve of photographic emulsions. It is commonly interpreted as a measure of the contrast reproduced in a negative image, that is, the ratio of negative contrast to original subject contrast for a given range of tonal values. Therefore, one of the primary uses of gamma is its employment as a yardstick. It measures the degree of development of photographic materials, since changes in development vary contrast or vary the slope of the curve. (Exposure changes, as previously explained, shift the position of the points right or left on the log E axis without altering the slope of the curve. Thus, the tendency is for exposure to control the density and development to control the contrast of the image reproduced. Remember the expression, "Expose for density—develop for contrast.")

Gamma may be likened to the slope of a road. Mathematically, it is the ratio of the height gained to the distance traveled in a horizontal direction. In determining gamma, the height is density (D), and the horizontal base is the log of exposure (log E). An ideal film and processing for instance might produce an increase of .3 density for each .3 increase of exposure. This ratio is 0.3:0.3 or 1.0.

Normal photographic subjects call for films with a gamma value around 0.75, varying from 0.65 to 0.90. Such an emulsion will record the wide range of tones which are present in outdoor scenes. In practice, each of the main groups of negative materials has its own individual characteristics. Gamma is useful to the photographer because it tells him how his photographic material will respond to changes in exposure and processing.

From the foregoing discussion, it may be seen that gamma is definable in different terms. Some more useful definitions include the following:

- Gamma is the numerical measure of the contrast reproduced in a negative image.

- Gamma is a numerical measure of the degree of development (for a given material).

- Technically, gamma is the slope of the straight line portion of the characteristic curve.

Gamma determination, once the curve has been plotted, can be accomplished in several ways, some of which are:

- **Basic Method**—This method, shown in the next figure, involves the ratio between densities and the exposures which produced them. Any two points on the straight line are chosen. (More reliability tends to result if the points are widely separated.) Gamma is the result of dividing the change, or difference in density, by the difference in log E between the two points. The formula is:

$$\text{GAMMA} = \frac{\Delta D}{\Delta \log E} = \frac{D_1 - D_2}{\log E_1 - \log E_2}$$

where:

$\Delta$ (Delta) = Symbol for change or difference.

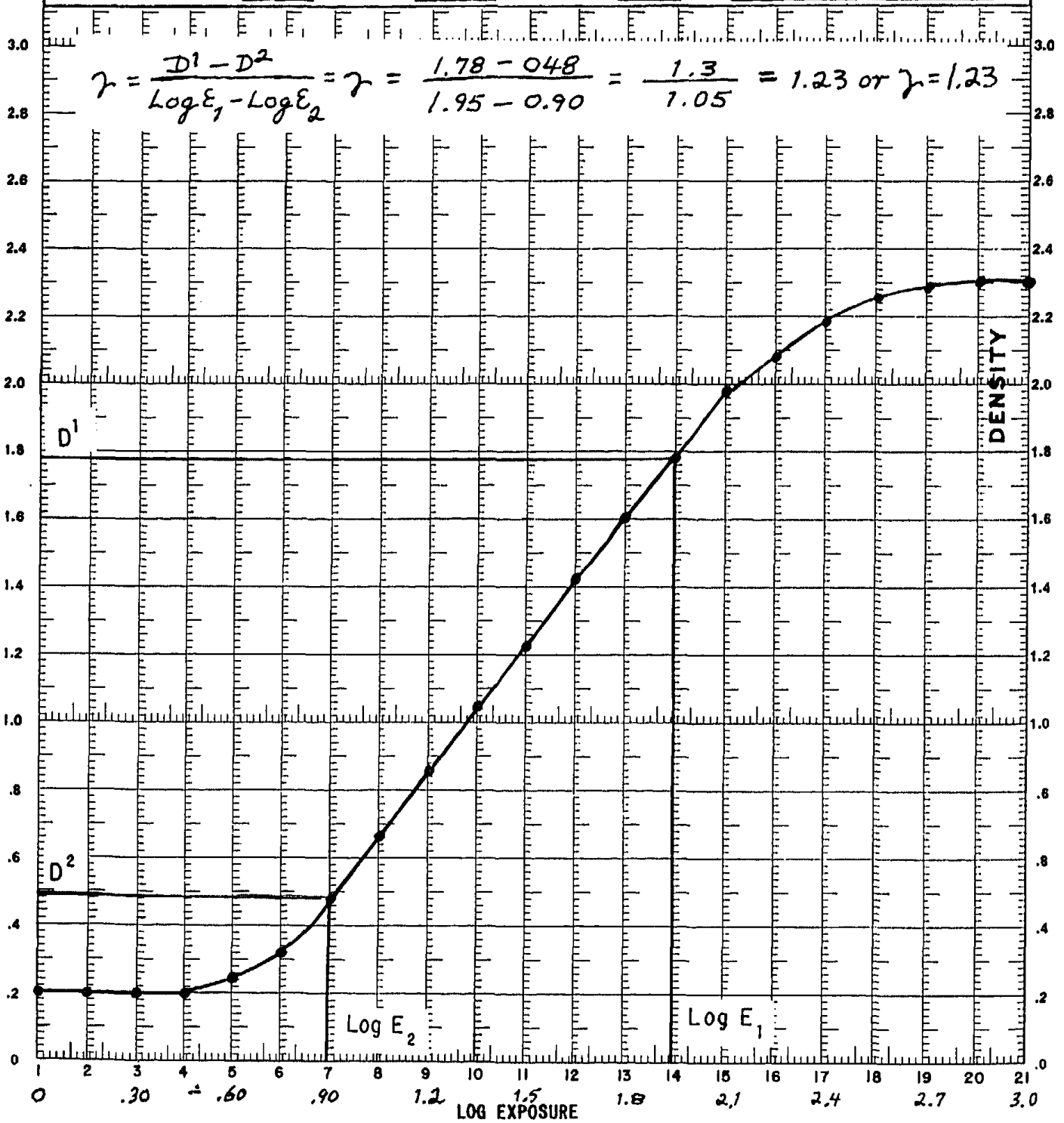
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____




**Basic method of determining gamma.**

The values of $D_1$, $D_2$, log $E_1$ and log $E_2$ are read directly from the graph. The mathematical computation for this method is shown at the top of the illustration.

● **Graphic Method**—From the inertia point (the point of intersection of the straight line extended to the log E axis) move to the right a distance of 1.00 on the log E axis. Gamma is the density reading at this point. For example, using the illustration on page 2-18, find the inertia point on the log E axis. In this case it is at 0.38 on the log E axis. Now move to the right 1.00 log E or to 1.38 on the log E axis. From this point on the log E axis draw a line straight up to intersect the straight line portion of the characteristic curve. A horizontal line drawn at this intersect point shows the density reading which is the gamma. In this case gamma is 0.96.

● **Quick Method**—This method uses a gamma gage. The arrow of the gage is placed on the straight line portion of the curve, with its baseline parallel to the log E axis. Gamma is indicated where the straight line intersects the scale. As you can see the gamma for the plot on page 2-19 is 0.82.

You can copy the gamma gage shown on page 2-20 to the scale indicated and when used with plotting sheets of the same scale, such as those copied from page 2-9, you will have at hand a rapid, accurate method of determining gamma.

● **Simplified Method**—A point is selected on the straight line portion of the characteristic curve at one of the minimum densities. From this point count over 50 spaces to the right in a horizontal direction. Between these two points, draw a horizontal line parallel with the log E axis. Next count the number of spaces in a vertical direction from this line until the straight line portion of the characteristic curve is intersected. Multiply this figure by 2 and divide by 100. For example, if 51 spaces are counted, the calculation is as follows:

$$\frac{2 \times 51}{100} = 1.02 \text{ gamma } (\gamma)$$

In the figure on page 2-21, a low density point at step 9 was selected. From this point, 50 spaces to the right is at 2.2 on the log E axis. Counting straight up from the horizontal line above this point to the intersect of the characteristic curve is 51 spaces. Thus:

$$\gamma = 51 \times 2 \div 100 \text{ or } \gamma = 1.02$$

## Gamma and Contrast

A negative contains many different contrasts. It has total contrast, defined as the difference in density between the extreme shadow and extreme highlight tones in the negative. Total negative contrast is a useful index to the variable contrast filter number with which the negative will probably print best. Total negative contrast is dependent upon many factors, including subject illumination ratio, camera exposure level, color of light, and gamma. Gamma is only one of the factors which control the total contrast of a negative. In addition, a negative has other forms of contrast as follows:

● *Shadow contrast*—associated with the characteristic of the toe portion of the characteristic curve and, therefore, unrelated to gamma.

● *Highlight contrast*—associated with the shoulder of the characteristic curve and to which gamma does not apply.

● *Midtone contrast*—associated with the straight line portion of the characteristic curve.

Gamma, therefore, is not a measure of negative contrast, nor will a control of gamma in different negatives ensure that they will all print with the same variable contrast filter. All of the frames in a roll of film may be uniformly developed to the same gamma; for example, 0.75. However, each negative will probably have a different total contrast because of variations in subject contrast, subject color, subject luminance, contrast, etc. Contrast, therefore, may best be defined as a range of densities produced by a combination of the subject luminance ratio and the amount of development given a film.

Film exposed on a cloudy bright (no shadows) or heavy overcast day could be developed to a high gamma (for example, 1.6) and still produce a flat negative, because of the small luminance range

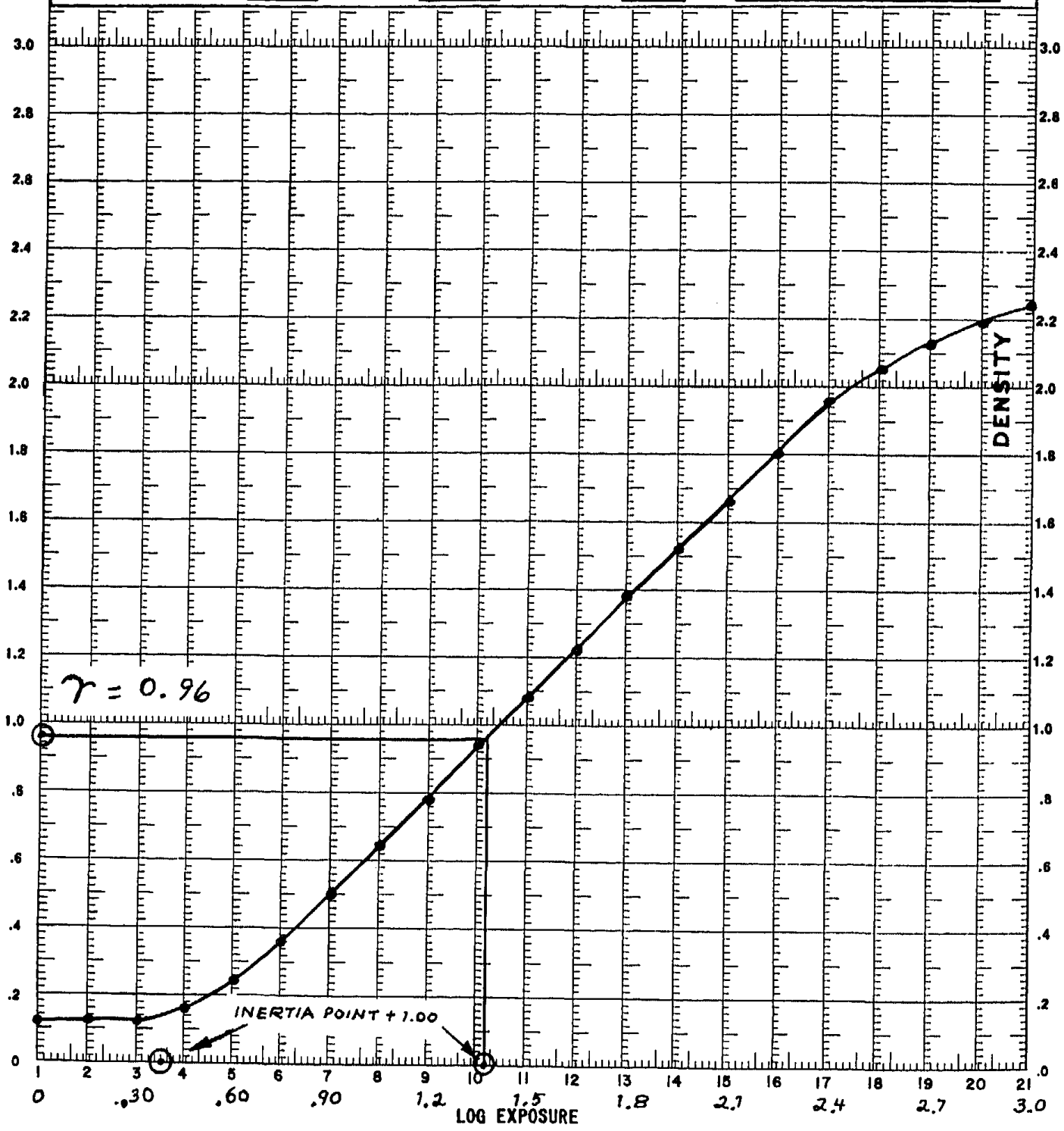
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____




**Graphic method of determining gamma.**

Sensitometer No._____ Neutral Density_____ Exp. Time_____ Illuminance_____

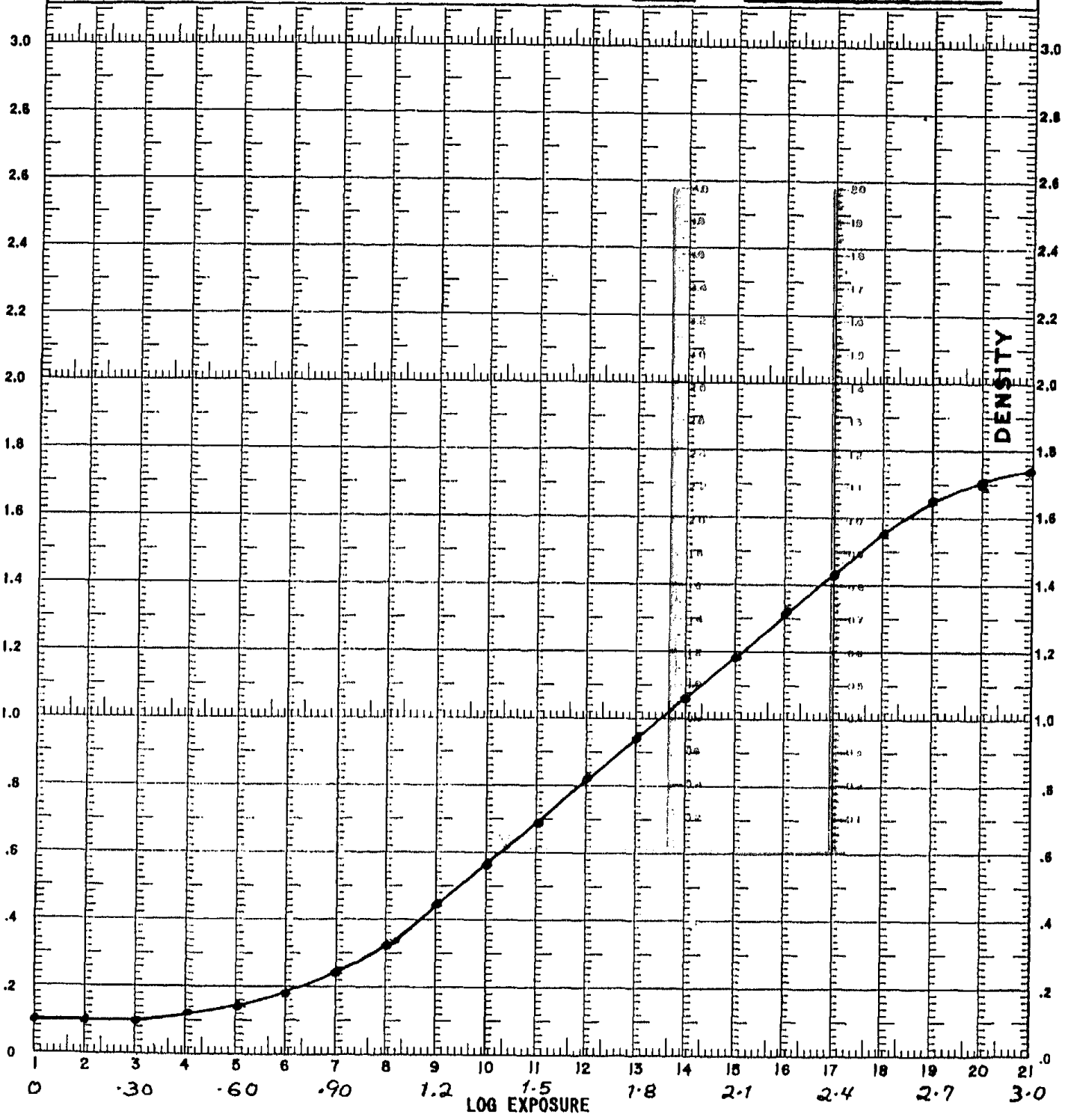
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

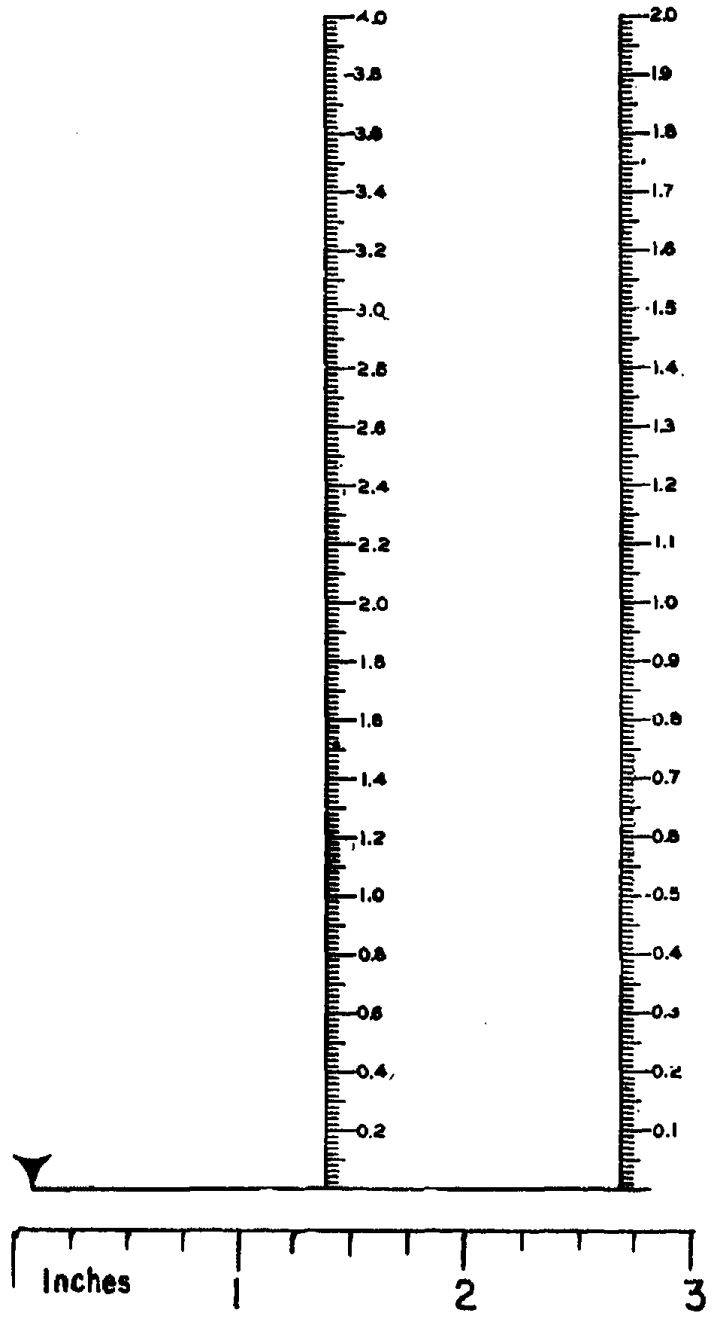
Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____




**Quick method (using a gamma gage) of determining gamma.**




**Gamma gage.**

of the subject being photographed. Another scene having a high luminance ratio could be photographed and developed to a low gamma of say 0.5, yet the contrast of the negative would be so high that it would have to be printed with a very low number filter.

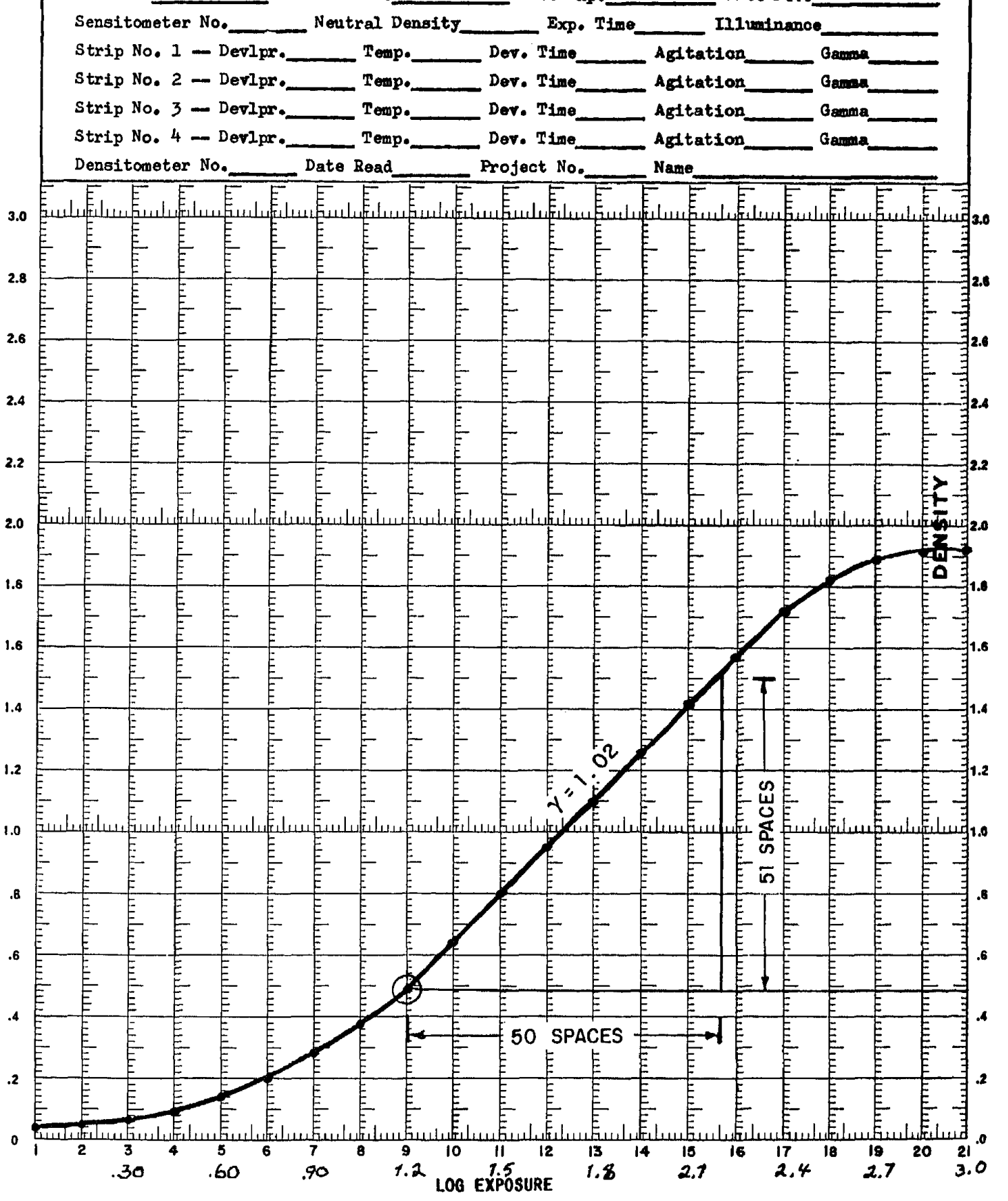
It should be understood that even though a negative can have a high total contrast, there may be little contrast in the shadows, if those shadows fall on the flat portion of the toe of the D-log E curve. If two films having the same characteristics are exposed to the same scene at the same or nearly the same time, and each film is developed to a different gamma, then more contrast can be expected in the negative developed to the higher gamma. This is true for those tones exposed on the straight line portion of the characteristic curve and to a lesser extent for tones exposed on the upper part of the toe.

If the basic formula for determining gamma is examined, $\Delta D$ (difference in density) may be considered the negative contrast (for the straight line) and $\Delta \log E$ (difference in log E) the subject contrast. Gamma can then be considered as the *ratio* between negative and subject contrast. A negative that was developed to a gamma of 1.00 has, for all straight line exposures, the same contrast range as the original scene. If the negative was developed to a lower gamma (for example, 0.50), it will have only half as much contrast as the subject. Again, this applies only to the straight line portion of the curve.

Gamma, however, which is the slope of the straight line portion of a characteristic curve of a negative, is not always an appropriate basis for measuring the effects of exposure and development. Gamma does not take into account the fact that the toe of the curve is normally involved in the exposure of a typical continuous-tone film. Also, D-log E curves for different films have different toe lengths and toe shapes; consequently, film developed to a given gamma may not yield a sufficiently uniform density range for use in ordinary continuous-tone photography. To provide a more uniform density range, a form of average gradient, called *contrast index* is used. In some applications, however, where the characteristic curve has a long straight line region, and the film is exposed so that the image is recorded wholly on the straight line, gamma is still a valid method of measuring density range—in aerial photography for example.

## CONTRAST INDEX

As you know, contrast means the range of densities produced by a combination of subject luminance ratio and the amount of development. The luminance ratio of the scene can't be controlled outdoors and can be controlled only within limits in the studio. When the degree of development is controlled, one variable that affects




**Simplified method of determing gamma.**

films are developed to a given *contrast index value*, they can be made compatible with a particular printing system and any variations in contrast caused by different subject luminance ratios can be adjusted in printing by the selection of appropriate variable contrast printing filters. Controlled film development helps to produce a uniform standard of print quality, as well as making the printing easier and less costly in time and material.

> Contrast index has the same uses as gamma. It is an index number that can be used for processing control purposes. When films or developers are compared, the test images should all be developed to the same contrast index. Obtaining a constant contrast index, like gamma, does not guarantee that all negatives will have the same total contrast, nor that they will all print similarly.

Contrast index, which is measured over that part of the D-log E curve normally used in correctly exposed continuous-tone negatives, is the *average* of the slope, and distinct from the *straight* line slope of gamma. An average in this context is the slope of a straight line drawn between two definite points on the curve. The straight line is drawn between two points on the D-log E curve that represents the highest (D-max) and the lowest (D-min) *useful* densities in a continuous-tone black and white negative.

The two points representing the highest and lowest useful densities are found by drawing two arcs from a common center which lies on the gross fog axis. The lowest useful density point is at the point of intersection of an arc having a radius of 0.2 in log exposure units and the D-log E curve. The highest useful density point is at the point of intersection of an arc having a radius of 2.2 log exposure units and the D-log E curve.

To locate the points of intersection, a transparent gage with two arcs scaled in tangent values is required. The one shown here can be copied and printed on film for use. Remember, that the radius of the low density arc must be scaled to equal a radius of 0.2 in log exposure units as marked on the graph paper used to plot the characteristic curve you will be analyzing. The

To use the gage, place it on the characteristic curve with its gross fog line on the gross fog density of the curve. Move the gage right or left until the low density arc intersects the toe of the curve at a value marked on the low density arc, which is the same as the value at the intersection of the curve with the high density arc. The value found is the contrast index.

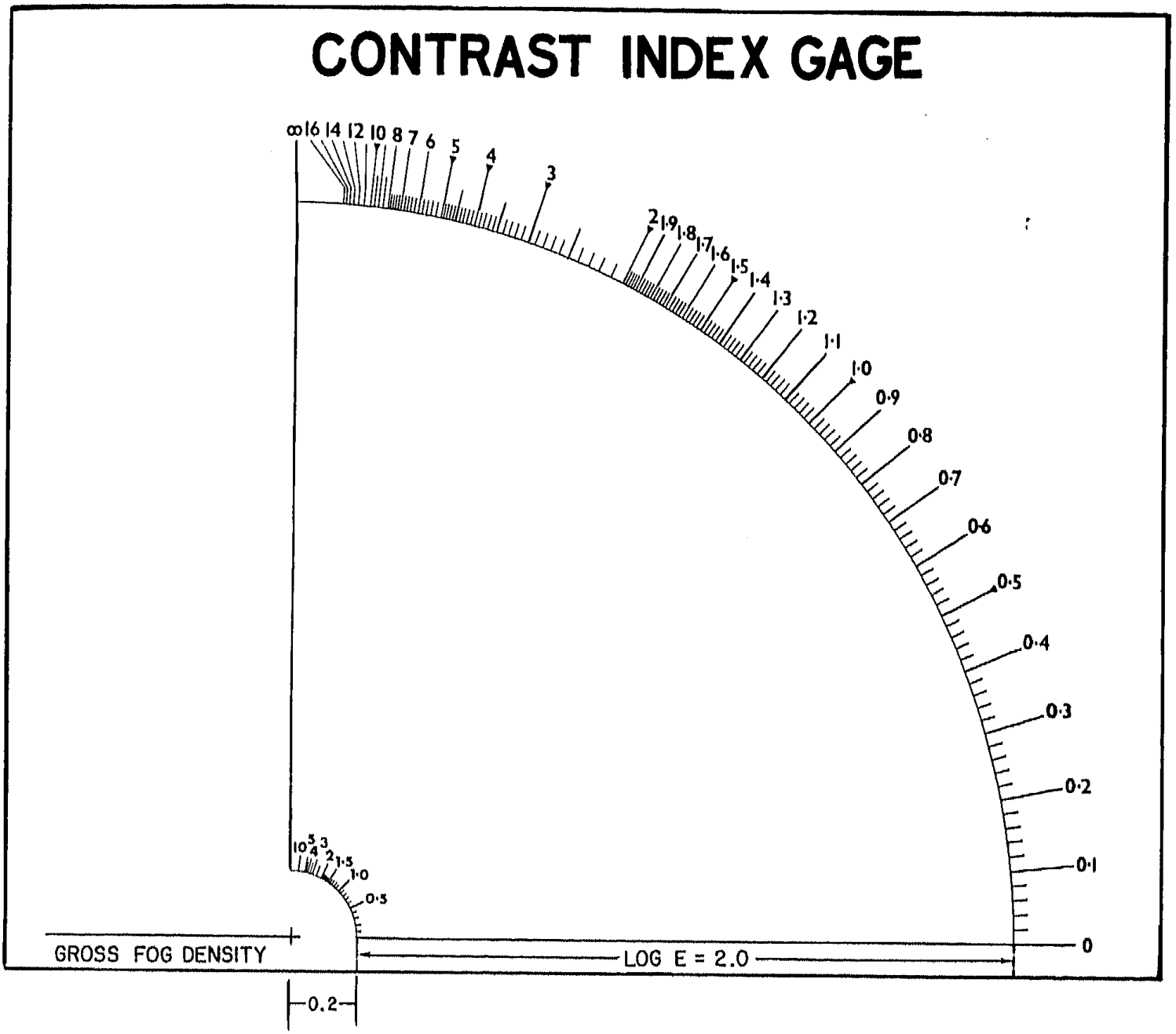
The contrast index gage shown on page 2-23 can be copied to the same scale as the plotting sheet on page 2-9 and used with reproductions of that page.

## CONTROL IN PROCESSING

The gamma or contrast index value of a photographic material is not fixed. Either can vary within limits by the choice of developer and the method of development. It is important for you to realize that the contrast obtained by development depends on the *amount of development*, rather than on the development time alone. To obtain an accurate gamma or contrast index, therefore, other variables or the total amount of development, such as developer temperature, the condition of the developer, and the degree of agitation, must be carefully controlled.

The densities of a characteristic curve are changed by changes in development. Therefore, gamma and contrast index values are useful as a measure of the degree of development. Gamma and contrast index vary directly with the degree of development; the greater the development, the higher the gamma or contrast index—up to gamma or contrast index infinity.

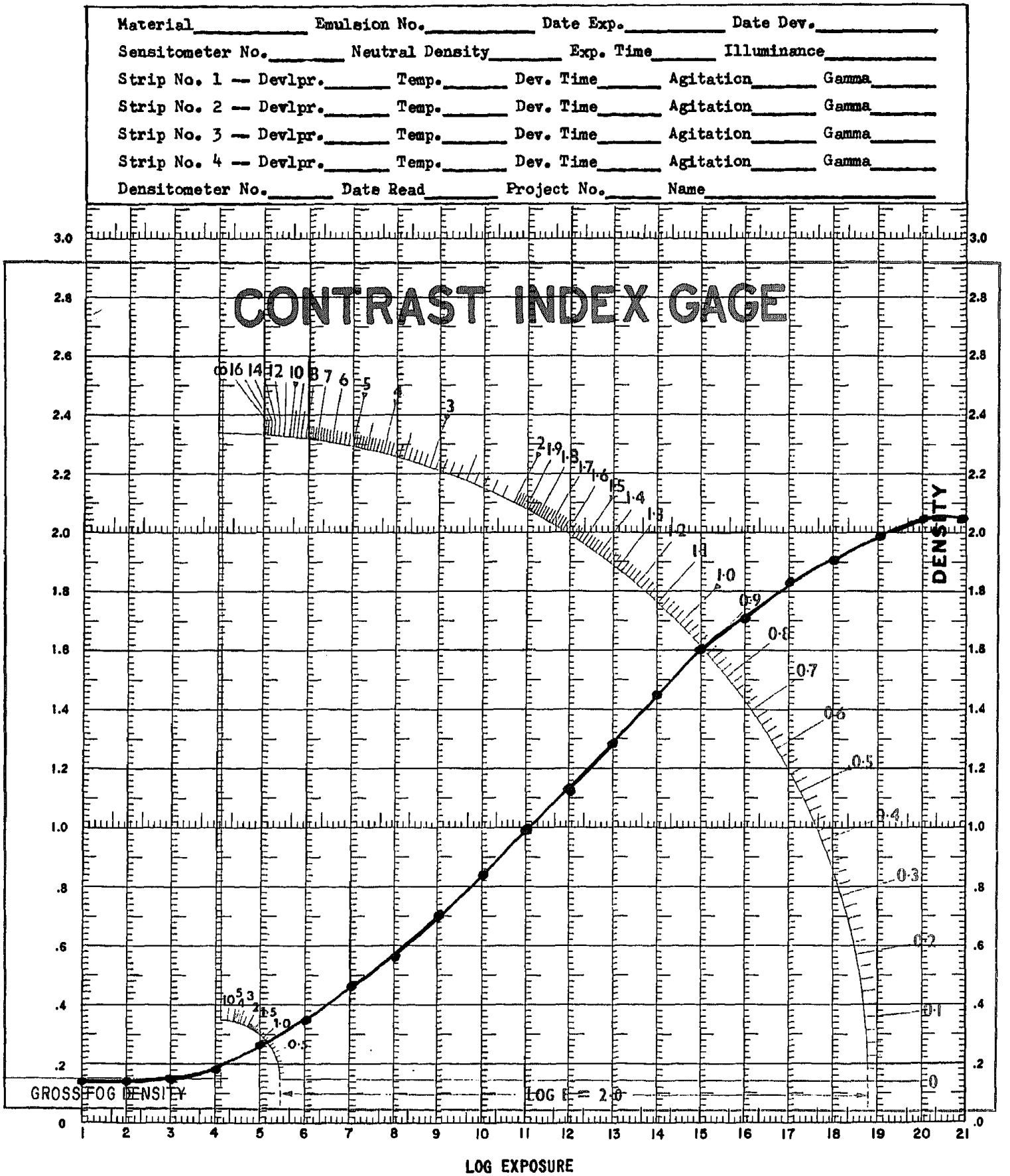
Gamma and contrast index are two of the most important tools used in processing control. Films developed to the same value, for example, show comparable tone reproduction. When you want to determine if processing is consistent, sensitometric strips are processed along with your picture film and the gamma or contrast index plotted. If the gamma or contrast index remains constant, processing is consistent. Whenever practicable, the sensitometric or test strips should be printed on the picture film itself, such as on an edge of sheet film or at the end of rollfilm.




## USING GAMMA AND CONTRAST INDEX

In picture making photography, generally speaking, a gamma of about 0.65 to 0.90, or a contrast index of 0.56 to 0.60 has been found to be adequate, except in some printing systems such as those using specular light sources. For these systems a lower value may be more suitable. The best gamma or contrast index for a particular printing system can be determined only by practical tests. These tests can be made simply by developing several equally exposed films to different gamma or contrast index values. Then, the negative that prints best on the paper and with the printing filter normally used will have contrast most suitable for the printing system in question. In using variable contrast paper aim for negatives that print well with a No. 2 filter. If the value needed to obtain satisfactory prints with a No. 2 filter is much higher than a gamma of 0.90 or a contrast index of 0.60, check the enlarger lens and/or the printing filter to see if they are finger marked or dusty. Also check for safelight fog and low print developer activity. These may all be reasons for low print contrast.

If the required negative gamma or contrast index values are not reached in the developing time indicated by time-gamma or time-contrast index curves for a particular film and developer




Using a contrast index gage to determine contrast index.

for low activity, and be sure the films are properly agitated in the developer. These are some of the main reasons for low negative contrast.

### Time-Gamma and Time-Contrast Index Curves

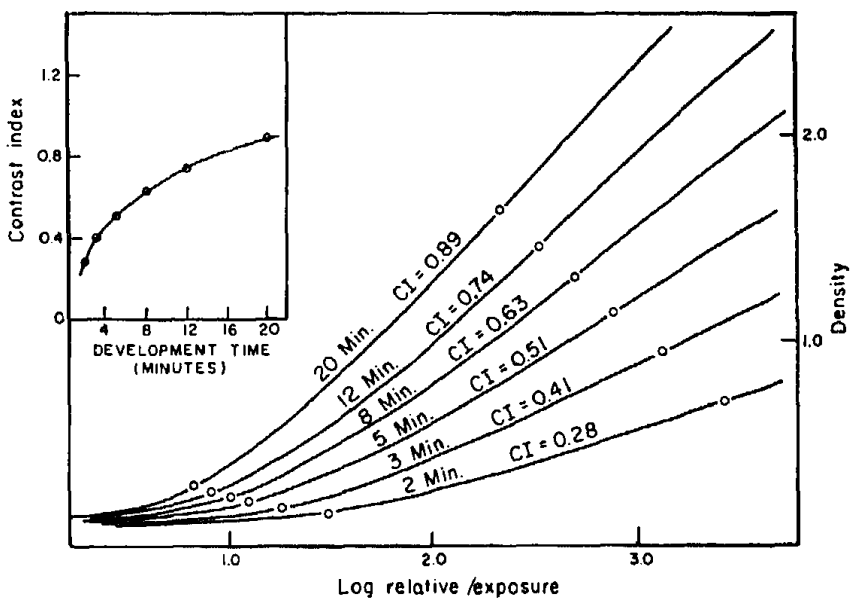
Time-gamma or time-contrast index curves can be plotted to summarize the behavior of any film-developer combination. A time-gamma or time-contrast index curve can be used to indicate the time of development required to reach the desired gamma or contrast index, or the processing latitude for a specific gamma or contrast index tolerance. Time-gamma and time-contrast index charts can be made to show the maximum gamma (gamma infinity) or maximum contrast index (contrast index infinity) obtainable with a given film-developer combination.

The following figures illustrate time-gamma and time-contrast index curves and the family of curves which produces them. The curves are constructed in the manner shown in the illustrations. A small graph is drawn in the upper left of gamma or contrast index as appropriate. The gamma or contrast index obtained from each sensitometric strip of the film in question is plotted against the time required to produce it by placing dots in their proper position on the graph. A french curve is used to connect the dots.

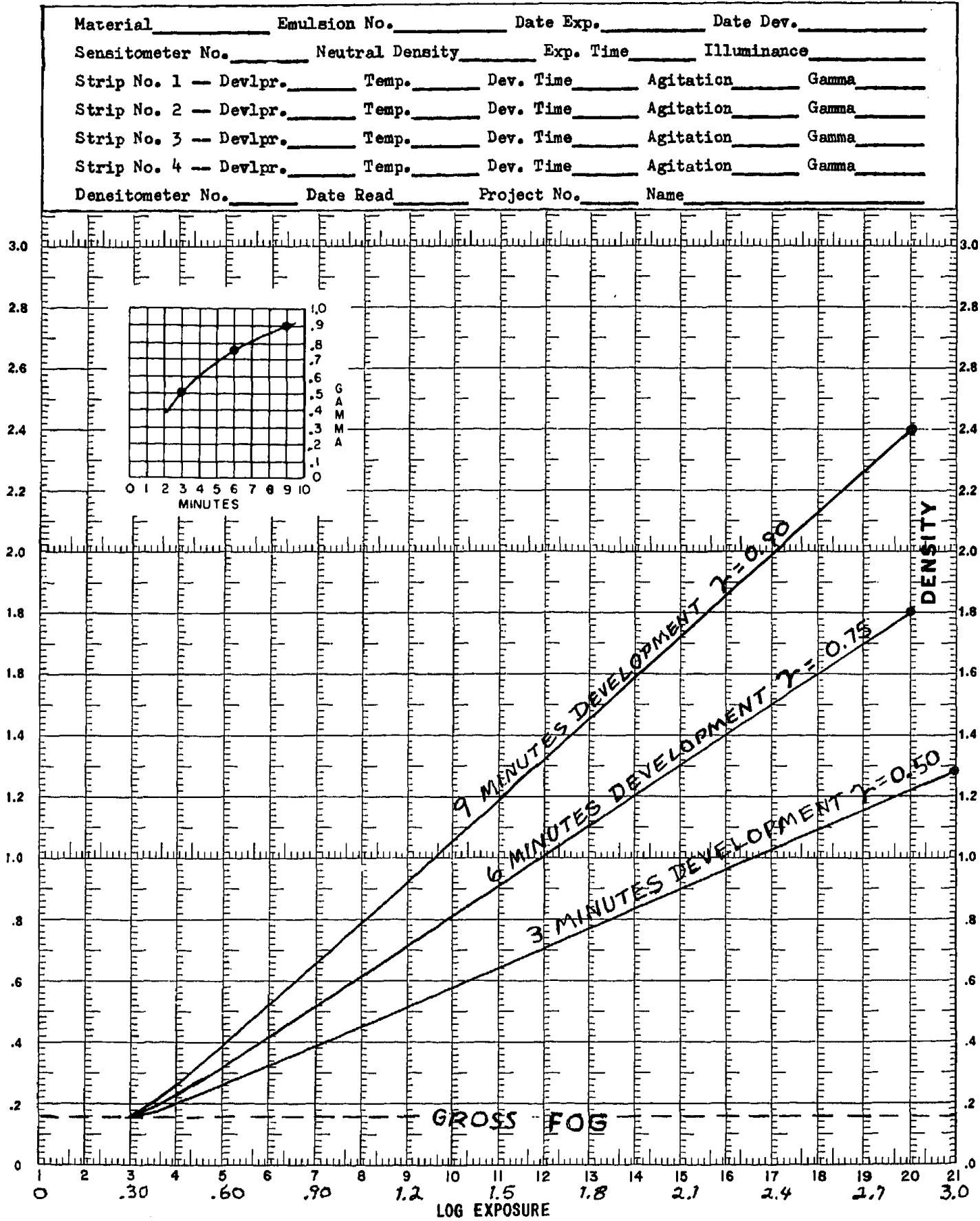
To use the curves, select the required gamma or contrast index from the vertical column of the small graph, and read the development time needed from the times given just below the base line or horizontal axis. These times should be based on negatives made under average conditions. If the negatives subsequently developed are too low in contrast, choose a higher gamma or contrast index value. If the contrast is too high, choose a lower value.

The processing latitude, that is, the range in times of development for any given tolerance in gamma or contrast index, may be found by determining the time of development for the minimum and maximum gammas or contrast indices which are acceptable.

An examination of the time-gamma or time-contrast index curves will show that as development increases, gamma or contrast index also




**The application of the contrast index to a family of D-log E curves obtained by developing a negative material for a series of development times. The measured values of contrast index are plotted against development time, in the upper left-hand corner of the figure, and the resulting curve is used in choosing the development time when the contrast index desired for a certain class of work is known.**

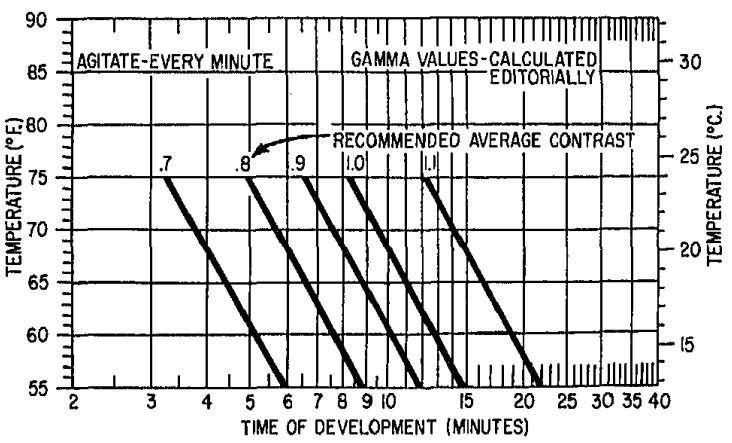



Time-gamma curve.

increases, rapidly at first and then more slowly. After a period of time there is very little increase in gamma or contrast index even though development is prolonged. This indicates that for any particular emulsion and development condition, the higher the gamma or contrast index, the greater the processing latitude. This also indicates that the lower the gamma, or contrast index, the more precisely the processing conditions must be controlled to obtain uniform development.

### Time-Temperature Charts

One of the primary factors governing the density of an image is the temperature of the developer. The higher the temperature, the greater is the activity of the solution. As the temperature drops, the developing time must be increased. Since gamma or contrast index must also be considered, typical time-temperature charts include a gamma and/or contrast index value which varies according to development time and temperature. Designation of this value allows controlling of the development in order to produce a desired gamma or contrast index. By consulting a time-gamma or a time-contrast index temperature chart, which is published by the manufacturer of the film, determination of the proper developing time under varying conditions can be made. A typical chart, this one using gamma values, is shown. To use a time-gamma or time-contrast index temperature chart, follow the line indicating the temperature at which the film is to be processed until the desired gamma or contrast index line is intersected. From this point drop straight down to the time base. The intersection of the vertical line and the time base line indicates the proper developing time at the recommended agitation. For example, using the time-gamma temperature chart shown, assume the film is to be processed at 70°F to a gamma of 0.90. Find 70°F and follow the horizontal line until it intersects the bold line labled .9 (0.90 gamma). From this point drop straight down to the time base line and read 7.5 or 7 1/2 minutes of developing time at the recommended agitation.




**Time-gamma temperature chart.**

## CHEMICAL QUALITY ASSURANCE

The equipment and methods presently used for mixing photographic solutions are the results of changes that have taken place over many years. These improvements have been made in order to keep pace with the better photographic quality now possible with advanced designs in optics, cameras, processing equipment, and the ever-increasing variety of improved sensitized materials.

Substandard solutions make it impossible to carry on a processing operation within controlled limits. Any degree of uniformity obtained from a controlled operation using substandard solutions is purely accidental.

The preparation and use of photographic solutions must be a systematized procedure based on accurate measurement and standardized methods. The highest quality standards can be achieved only when the conditions of exposure, chemistry, and processing are all normal, or within operating tolerances. Then results are predictable.

In certain critical processing areas, chemical analysis is used to check all solutions before they are used, to check them during use, to keep chemicals up to standard, and to locate troubles from faulty chemicals. Analysis of the components of processing solutions is often used as a basis for discarding solutions or adjusting their composition for future use. The use of such procedures permits the determination of proper replenishment formulas and replenishment rates and promotes economy in consumption of chemicals. Quality assurance procedures guarantee that all solutions are properly mixed, properly used, and discarded at the proper time.

As important as chemical quality assurance procedures are, they must be supplemented with

chemical and photographic data can then be correlated to determine the control limits which are used by the laboratory. It is possible for sensitometric data to show a characteristic curve which is gradually bending out of shape, when the slope is changing, or when other variables seem to be entering the picture. The problem may be due to any number of causes; however, the chemistry of the photographic process should be examined as one of the possible causes. It may be found that the agitation method has been changed; then again, the cause might be improper mixing of the developing solution.

## CHEMICAL ANALYSIS

Much of the chemical analysis which you will perform may be accomplished through the use of common sense. The same thing holds true here as it does in the visual or subjective approach to quality assurance of negatives and prints. Such things as cleanliness, accuracy, and proper preparation of solutions should be practiced at all times. Contamination can ruin a developer in a short time; this, in turn, will ruin the film. Such things as dirt and dust in the solution can cause spots on the film.

Before it is used for mixing and measuring chemicals, all equipment should be cleaned with extreme care. Use a good quality detergent of medium strength to wash glassware and other vessels. Be sure the items that have been washed are well rinsed with clean tap water. Keep the entire area clean to prevent contamination and ensure accuracy.

Some of the more common chemical analysis methods you will use are:

- Determining pH
- Measuring specific gravity
- Sensitometric testing

Although there are several reasons for certifying photographic solutions, the principal one is to get desirable, predictable, and repeatable results. Depending upon the criticality of the mission, certifications may be limited or extensive. For example, some noncritical operations may require no more than the personal statement solutions were properly prepared; some highly critical missions may require complete sensitometric and chemical certification.

Control of a photographic process requires that the chemical concentration of the solutions be maintained. Chemical analyses that indicate chemical concentration are of value for control action only when the samples analyzed are representative of the processing solutions. A correct analysis of an improperly taken sample may do more harm than good in controlling the process.

Processing solutions may be turbid or contain floating particles, dispersed oil droplets, or a precipitate. Even a clear solution may have different concentration levels in different parts of the processing machine tank. For instance, the chemical composition at the point where the film enters may not be the same as in other parts of the tank. For such cases, a prescribed procedure must be used, with all samples being taken from the same location, such as from a point near the tank overflow. These samples will be representative of the solution at the prescribed sampling point and successive analyses will indicate variations in overall concentration.

Before sampling large batches of newly mixed photographic solutions, allow sufficient time for all the chemicals to dissolve properly—generally about 30 minutes to an hour.

Once you take a sample from the processing solution, an aliquot representative must be taken from the sample bottle for analysis. For a volumetric analysis, the aliquot is withdrawn 1 inch below the surface of the solution with a pipet. In general, no sample bottle should be shaken, and it should be allowed to stand for 10 minutes after taking the sample from the processing solution. This wait allows large particles to settle or allows turbidity (caused by aeration) to clear.

### Chemical Certification

The chemical certification of processing solutions seldom requires a complete chemical analysis. Ordinarily, determining the pH and the specific gravity of the solution will be enough—particularly if these tests are followed by a valid sensitometric test.

CERTIFYING THE pH OF SOLUTIONS.—As you know from your study of

module 3 of this RTM series, pH is one of the first tests made of a photographic solution. You also know that the pH of a solution is the logarithm to the base of 10 of the reciprocal of hydrogen ion concentration. The electrical potential between the glass electrode of a pH meter and the solution surrounding it indicates the hydrogen ion concentration.

The pH values of processing solutions and of buffers and also the responses of electrodes depend upon temperature. Therefore, to obtain reproducible pH values you must standardize the temperature at which the measurements are made. Generally, you make pH measurements at the nominal temperature at which the photographic process is operated. A change of 10°F produces a pH change of approximately 0.10 in a processing solution at a pH of 10.5, and a change of approximately 0.20 at a pH of 13.0. Thus, temperature control is more important at higher pH values.

For proper temperature control, you should place all buffers, samples, and electrodes in a water bath within ±1°F of the appropriate temperature. The water bath should have a raised wire grid or other support for the beakers so that water circulating underneath will bring the solutions to equilibrium more rapidly. The water level should be about 1 1/2 inches above the grid. Arrange the water input and overflow so that there is no appreciable temperature difference in the bath. A thermometer should be mounted in the bath and checked periodically.

> You should consult the instruction manual for the particular pH meter you are using to determine how to equilibrate the glass electrode, and how to calibrate and adjust the meter.

When certifying the pH of a solution, you can take the pH reading of only one sample or you can read several samples. Of course, the more samples you read the more reliable your certification will be. More often you must determine the pH value of more than one sample. After four samples have been read, the meter should be cross-checked, then standardized as discussed in chapter 2 of module 3. Also remember, that no more than 15 minutes should elapse between any pH meter standardization or cross-check.

When using the multiple sample procedure, you determine the pH for each sample and take the average value. Check this value against the standard pH for that solution; and if it is within limits, enter the value in the appropriate place in your certification sheet. If the pH is not within limits, it is cause for further investigation.

CERTIFYING THE SPECIFIC GRAVITY OF SOLUTIONS.—As you remember, specific gravity is the density or "weight" of a solution relative to water. In order to measure specific gravity you float a hydrometer in the solution. Depending on how high or how low it floats in the solution, it gives you a reading of how much heavier or lighter the solution is as compared to water. The scale of a hydrometer is calibrated for reference to pure, or distilled, water at 60°F. The scale division of 1.00 marks the depth to which the glass tube would sink in distilled water. For liquids heavier than water, the hydrometer has a scale reading downward from 1.00 to 2.00. For liquids lighter than water, the scale reads from 1.00 to 0.7.

The measurement temperature must be specified and controlled because specific gravity is affected by temperature. (An increase of 5°F causes a decrease of 0.001 in specific gravity for most photographic solutions.) Specific gravity standards for many black and white processing solutions are set by mixing at 70°F because many are used at 70°F.

There are many applications of specific gravity in certifying a solution. For example, the actual dilution of a developer is obtained by comparing a fresh developer to a used one. Another application could be to compare a fresh fixing bath to a used one. Since the silver content of a fixer increases with use, it is logical to assume a change in specific gravity will occur. Through experience you will establish upper and lower control limits for specific gravity of the various solutions needing such a check.

Alone, most of the specific gravity readings you make are not enough to tell what is wrong. They simply indicate a change which can be the signal for further testing. If a developer in use is being replenished properly, specific gravity will be constant. If the flow of replenisher is accidentally stopped, a change of specific gravity will be evident. Replenisher flowmeters should also

indicate the problem, but a backup check of specific gravity and pH, coupled with sensi-strip processing can very well be desirable—especially since it can be made with practically no effort.

SENSITOMETRIC CERTIFICATION OF SOLUTIONS.—Once the developer has been mixed a sensitometric strip should be processed to check the developer solution. Assuming the pH and specific gravity measurements of the developer are within tolerances, this test is certain to prove out the developer.

If you are using a new formula for a developer, then time-gamma or time-contrast index charts, as appropriate, should be made up for the variety of films that are to be processed in it. Once these time charts have been made, you will get a known result with a given time, temperature, and agitation of the film in the developer.

After the developer solution has been proven, it is recommended that another sensitometric strip be processed with each batch of film processed. Then each sensitometric strip should be read with a densitometer and plotted on your chart.

Once densities are recorded and plotted, the gamma or contrast index and average density ($\overline{D}$) can be determined and plotted on the applicable control chart. (The density of step No. 11 is normally used as $\overline{D}$, and, for ease in locating, is usually circled when plotted.) If this procedure is followed continuously with each batch of film processed, you will have an accurate picture of the processing level.

## QUALITY ASSURANCE CONTROL CHARTS

In photographic processing, control charts are used to monitor the status of a specific chemical or solution, the physical process, and/or sensitometric process within a normal or abnormal pattern. A list of numbers must be studied carefully to see if any are out of line, but if the numbers are plotted on a chart you can instantly see if any are out of order.

Photographic quality assurance control charts can be prepared for gamma, contrast index, minimum and maximum density, average density, gross fog, temperature, pH, specific gravity, and other variables as required by your quality assurance program. Data relative to these and other specific factors must be collected and recorded if they are part of your quality assurance program. From the recorded data, calculation of the central or mean or average line, and the upper and lower limit lines, can be determined.

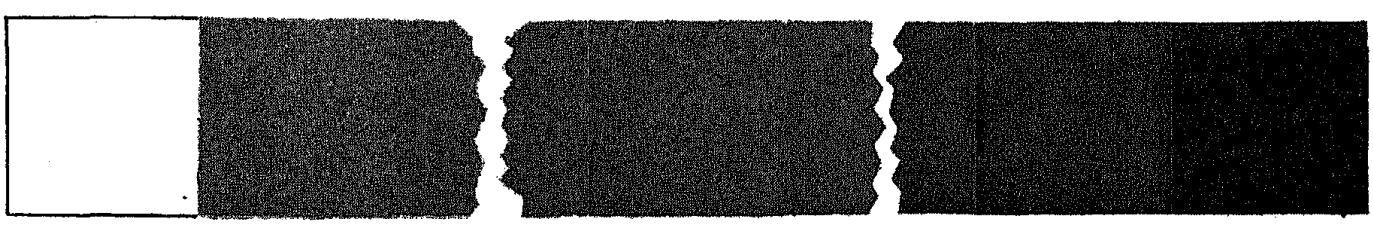
If, for example, the control gamma in an aerial film processor is 1.50 and the desired average density is 1.65, you must have a method for indicating when the gamma and/or $\overline{D}$ have varied to the point to which the end result is no longer desirable. If the gamma tolerance limit is $\pm 0.05$ and the $\overline{D}$ tolerance limit is $\pm 0.07$ and these limits are used with the control gamma and $\overline{D}$ previously mentioned, the control chart could appear as shown here.

The gamma and $\overline{D}$ obtained on each processing run are appropriately plotted on the chart. Other data such as time or machine speed, temperature, rate of replenishment, and footage processed are plotted or the figures noted. When the dots are connected they show what the processor is doing and which way the process is going.

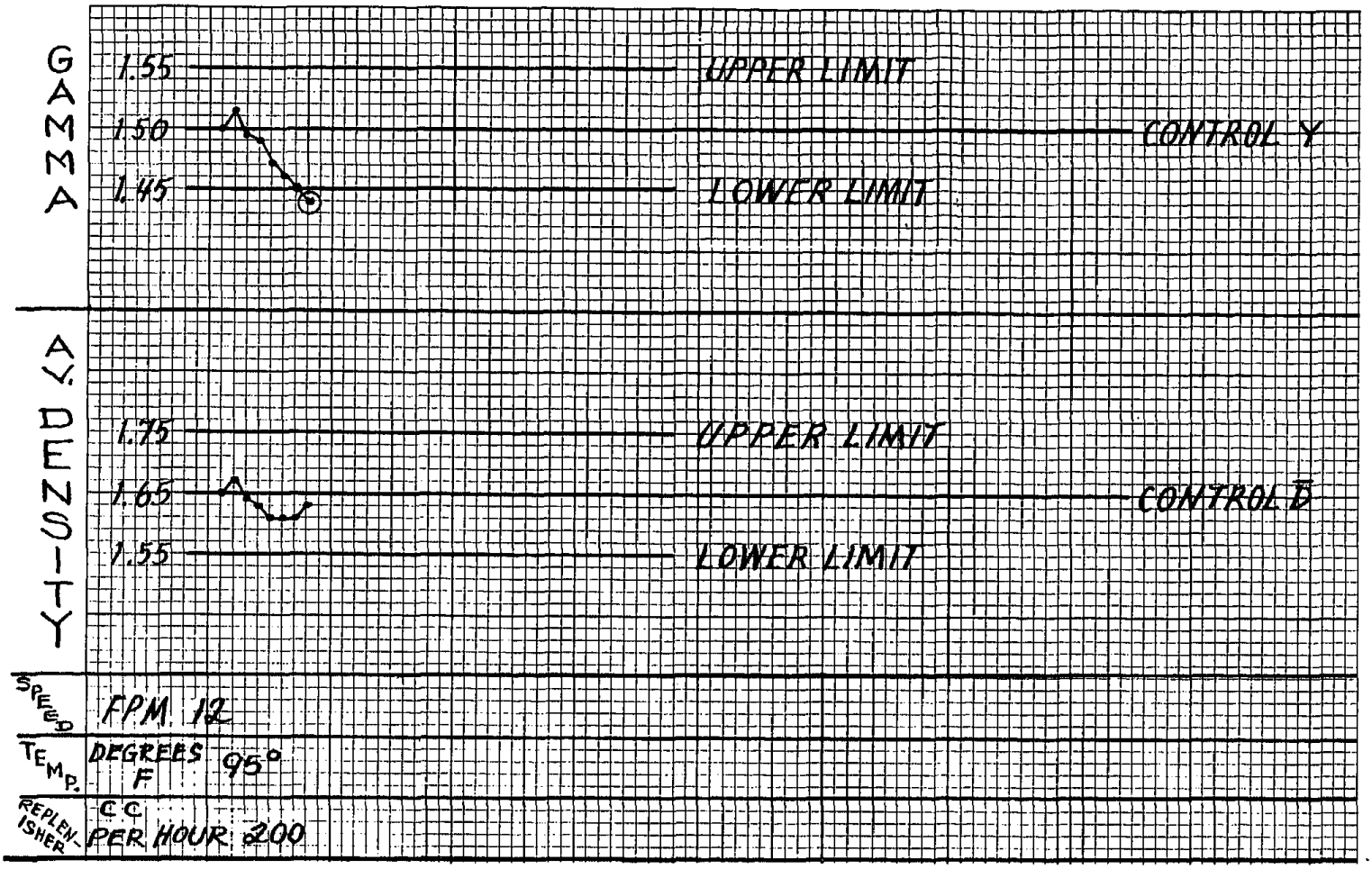
Remember that tolerance or control limits, once set, need not be left there forever. Continuously strive to improve the degree of control and, to do so, periodically reestablish closer control limits.

The amount of information you plot on control charts depends on several factors which may include, but are not limited to:

- The product quality required.



**Exposed and processed sensitometric strip.**




**Control chart.**

- The equipment available.

- Personnel available and trained for QA duties.

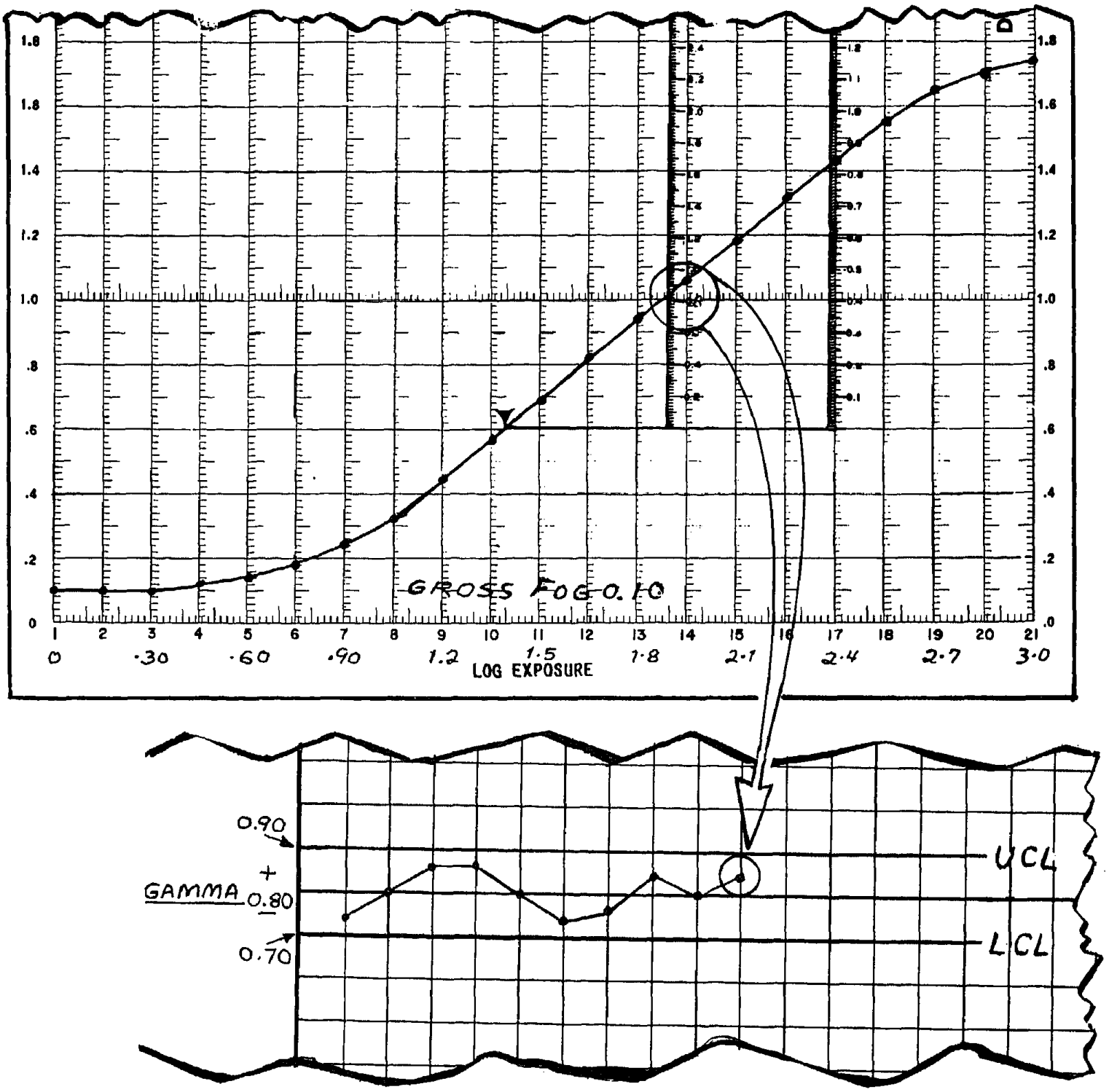
- The amount of production (the greater the volume of production the more need for an extensive QA program).

We do not suggest that you monitor all the variables we have listed. Nor do we suggest that you limit what you monitor. This is a discussion that will have to be made by each processing laboratory and may change from time to time.

The following illustrations serve as examples of how to maintain control charts and where the various information is taken from. But before we go on let us say that you have to have a standard or starting point for each of the variables you are going to measure. These standards are usually arrived at by sensitometric or chemical tests over a given period of time and may be provided by the manufacturers of the material under question. Generally speaking, when these tests are done by a processing laboratory they will be conducted by a PH who is a graduate of the photographic quality control course at the Rochester Institute of Technology, or by a PH who has had extensive OJT in QA. These people will analyze the tests conducted over the test period, apply statistical data, and arrive at workable standards or means, and upper and lower control limits. Therefore, in the rest of our discussion we will assume that these standards have been established. A word of caution, however; the chart, plot, and curve illustrations which follow are presented as *examples only*. They should not necessarily be used as a basis for the QA program in any lab. **They are examples only.**

As we have explained, gamma can be computed from the information plotted on a characteristic curve. Successive gamma values are then plotted on control charts.

- The developer is being over- or underreplenished.
- The film was over- or underdeveloped.




**Plotting gamma.**

or too low.

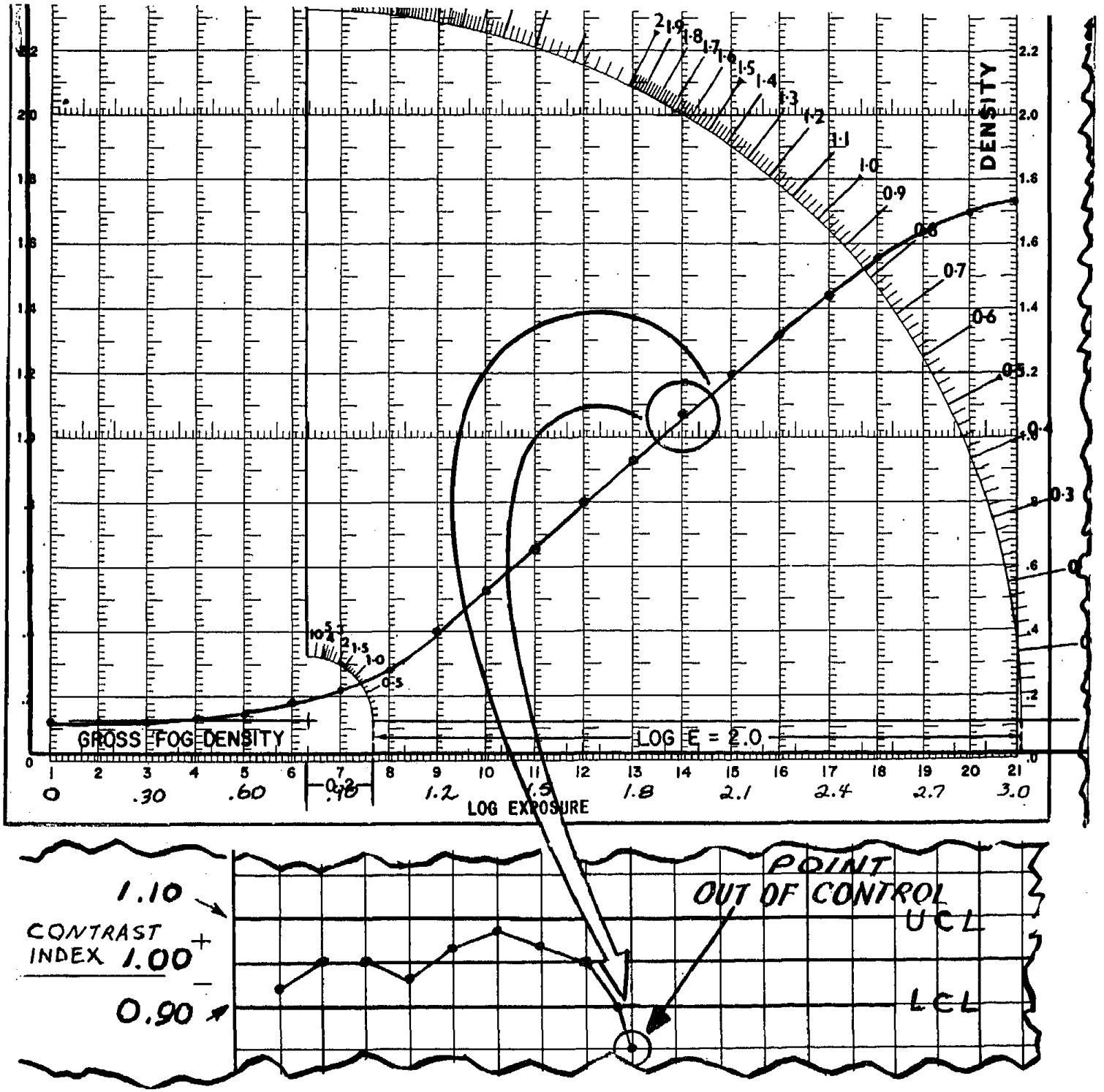
## PLOTTING *CONTRAST INDEX* ON A PROCESS CONTROL CHART

Contrast index, as you know, is determined by using a contrast index gage in conjunction with a plotted characteristic curve.

gamma also influence contrast index and will cause the plots on a control chart to go beyond the limits.

## PLOTTING *HIGH DENSITY* ON A PROCESS CONTROL CHART

The density step from a processed sensi-strip to be plotted as the high density on a control chart




**Plotting contrast index.**

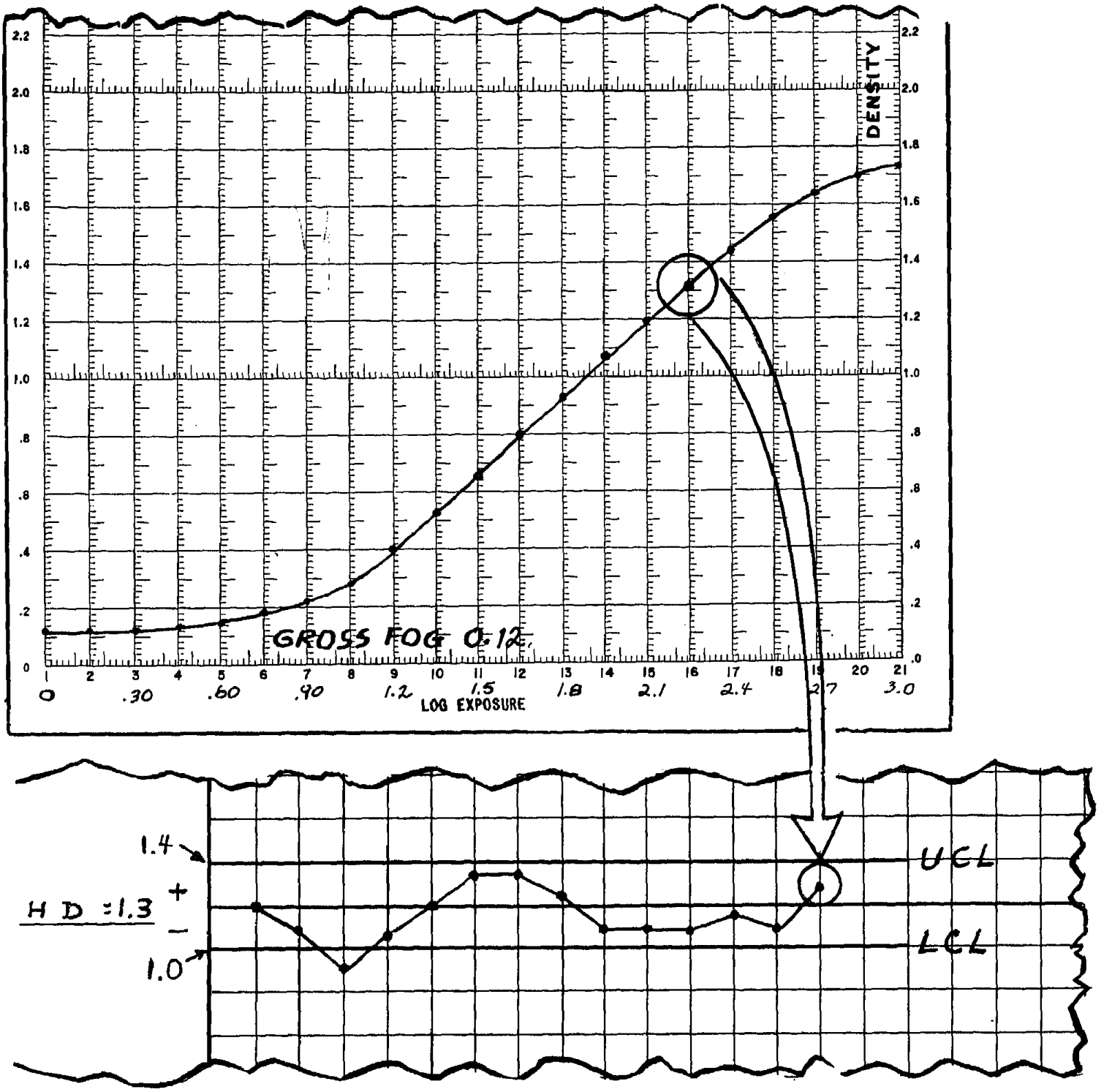
used for each reading or plot—until a new standard or mean is determined. For the purpose of our example we are plotting or measuring step 16 as high density.

The following factors can cause the high density to be out of control:

- Variations in the processing temperature.
- Over- or underreplenishment.

## PLOTTING *LOW DENSITY* ON A PROCESS CONTROL CHART

As with high density, low density readings should also be taken from a predetermined density step of a sensi-strip.




**Plotting high density.**

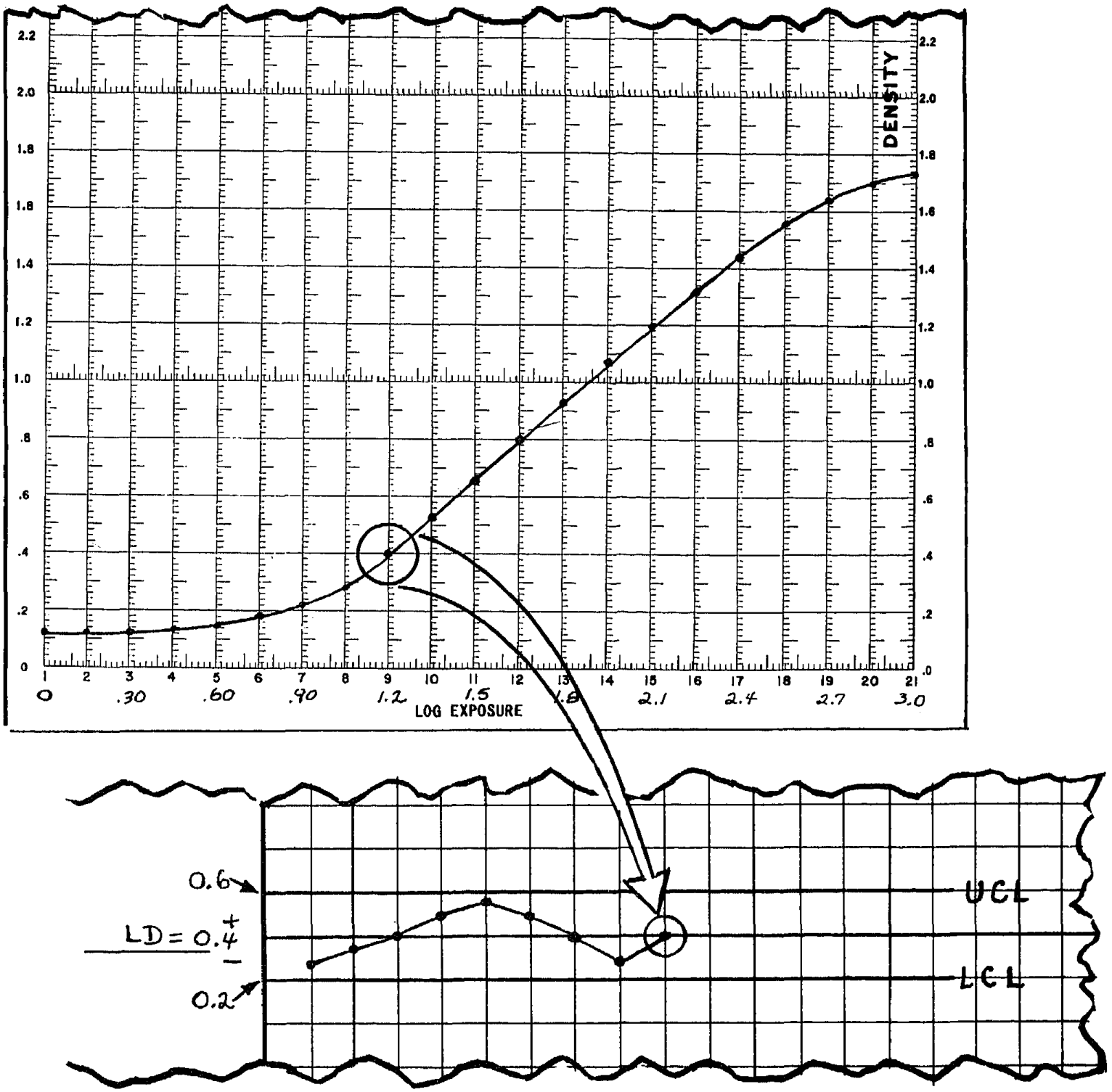
affect low density.

## PLOTTING *SPEED POINT* ON A PROCESS CONTROL CHART

The speed point, which is a measure of the effective film speed or exposure index of a film

films rated ISO, is determined by sensitometric tests and is established using a step on a sensi-strip which has a density of +.10 above gross fog for still picture continuous-tone film, and +.30 for aerial film.

Once the speed point step of a sensi-strip for a given film type and exposure and processing




**Plotting low density.**

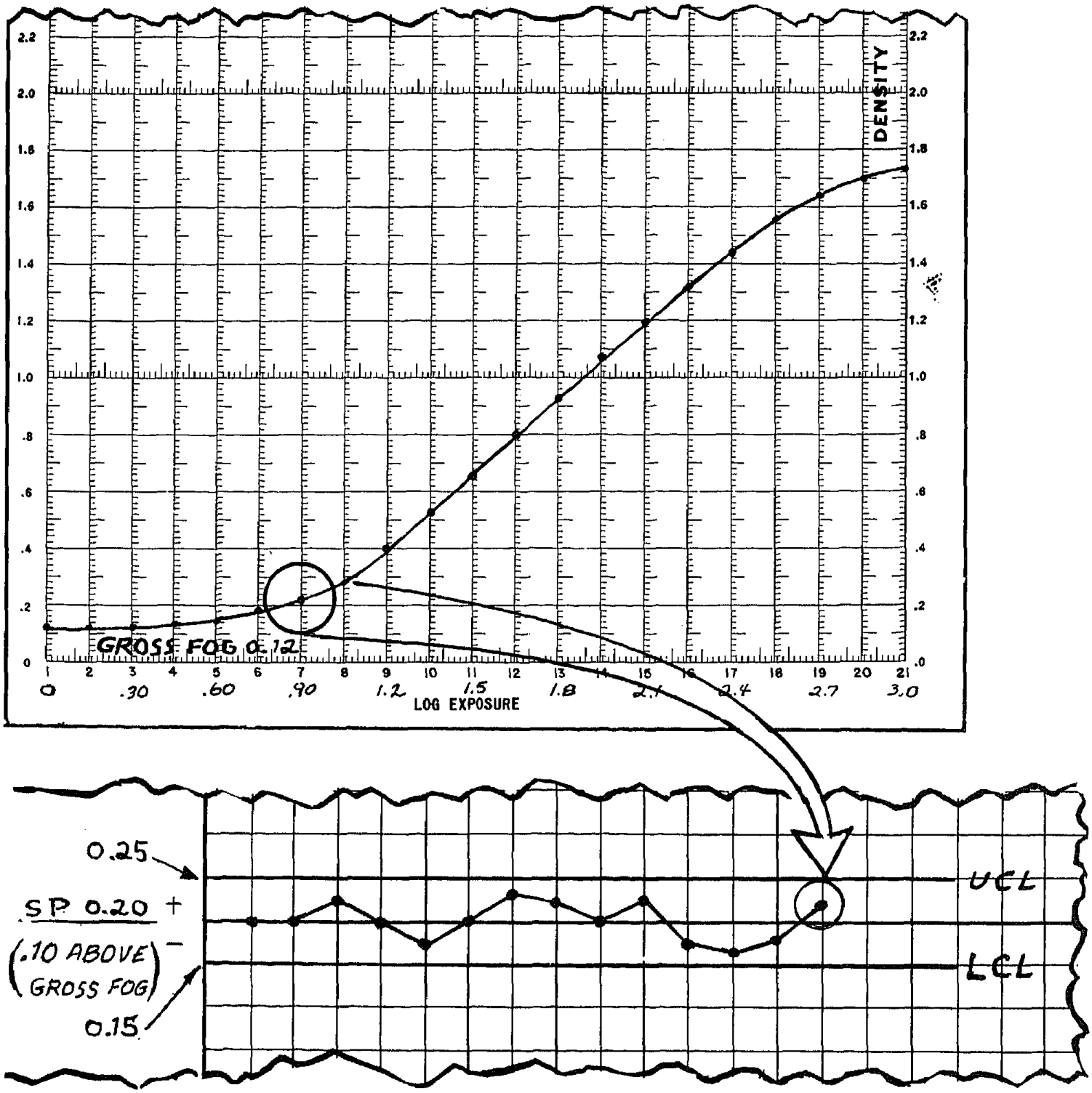
in successive sensi-strips and plotted on the control chart.

> Neither *effective film speed* nor the ISO for still picture (ground) film should be confused with *effective aerial film speed* or *aerial film speed* because they are not equivalent.

## PROCESS CONTROL CHART

Gross fog is read from a "clear" area of a sensi-strip—that is, an area that has not received exposure. All films have a gross fog density which is the result of several factors that may include:

- The density of the "clear" film base.

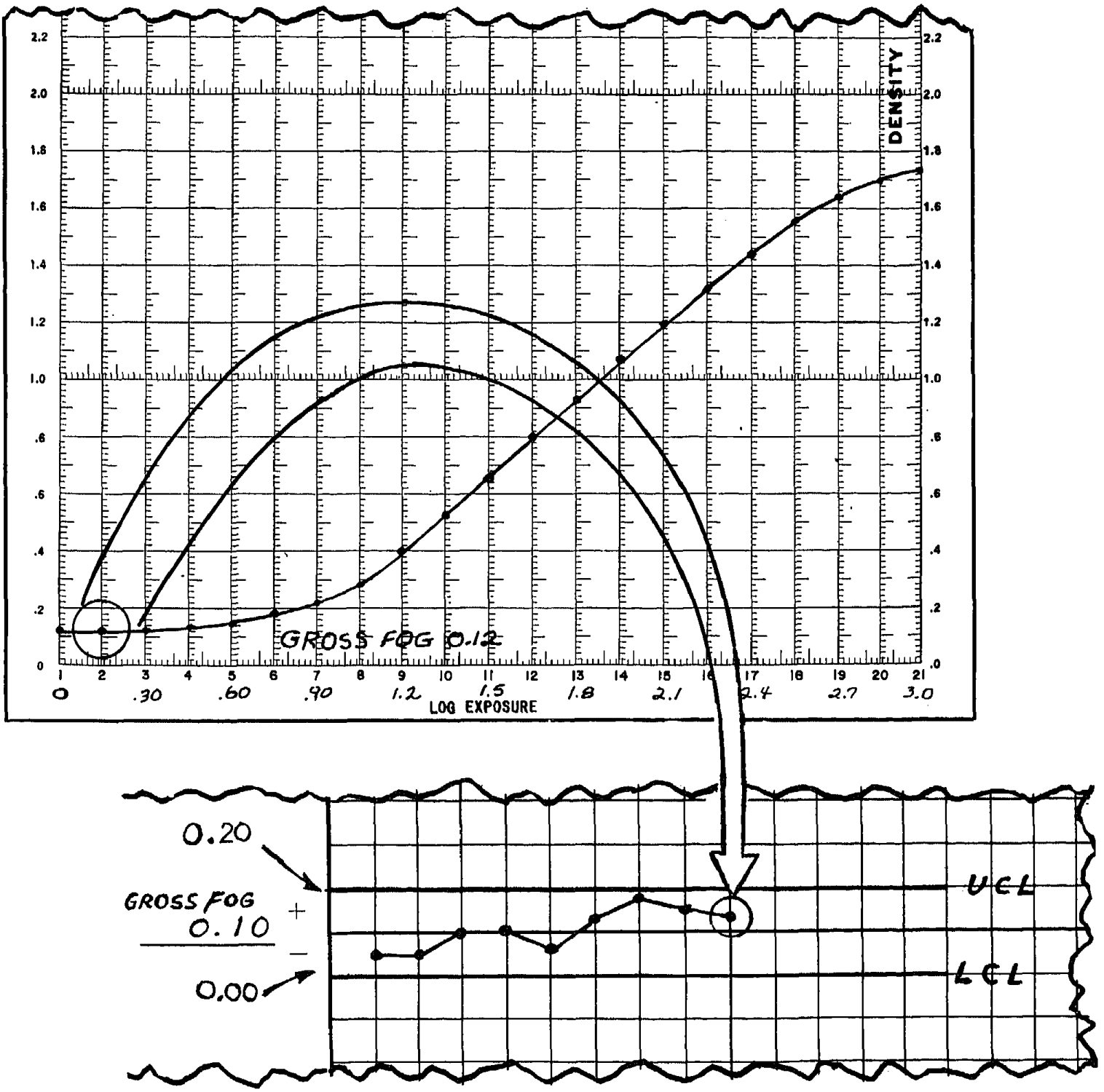



**Plotting speed point.**

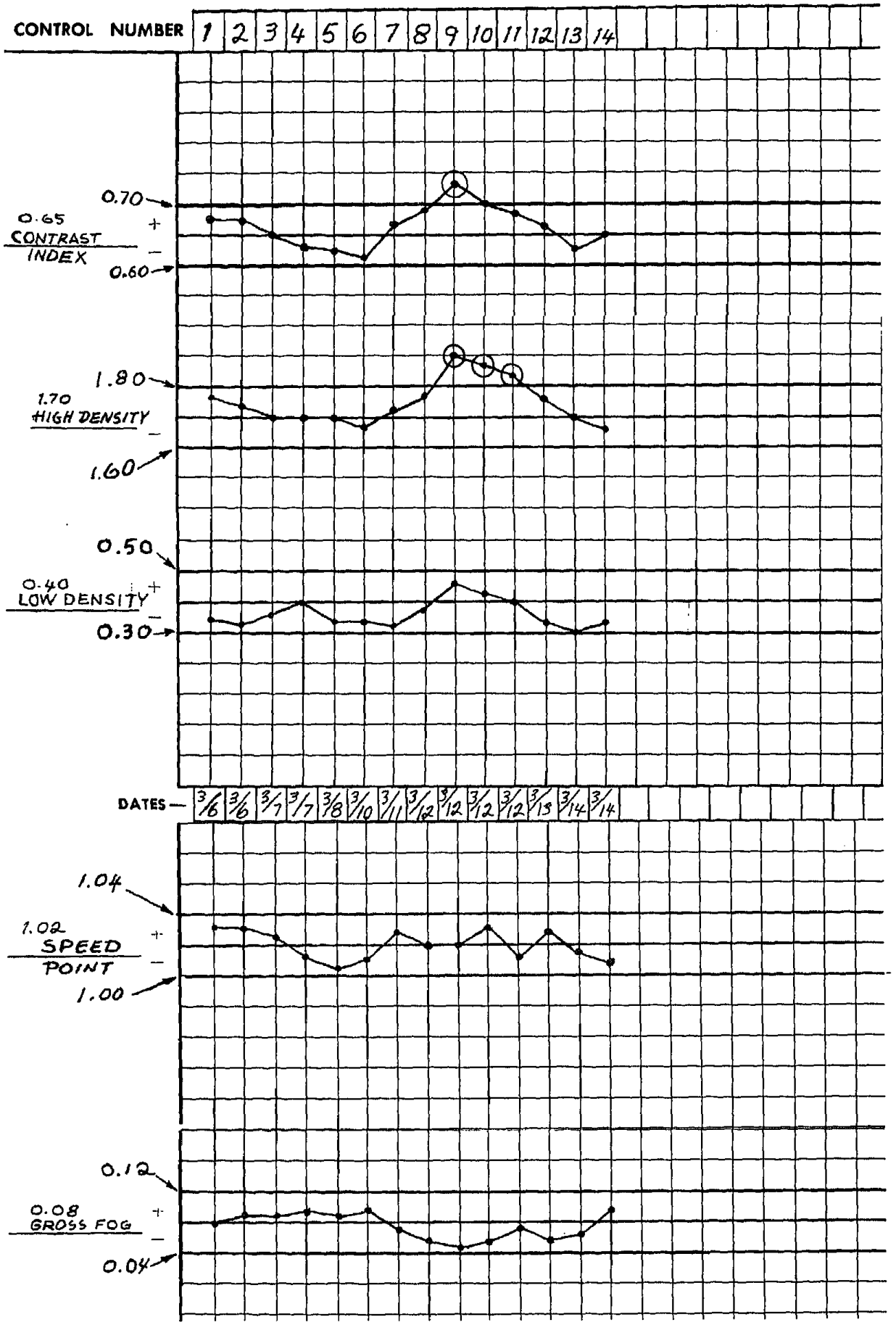
halides.

- Inadequate fixation (film not cleared).

appropriate control chart or use a piece of graph paper which can be posted near the process. A typical family of control charts for a process is




**Plotting gross fog.**


CONTROL NUMBER
1 2 3 4 5 6 7 8 9 10 11 12 13 14
0.70
0.65
CONTRAST INDEX
+
−
0.60
1.80
1.70
HIGH DENSITY
−
1.60
0.50
0.40
LOW DENSITY
+
−
0.30
DATES
3/6 3/6 3/7 3/7 3/8 3/10 3/11 3/12 3/12 3/12 3/12 3/13 3/14 3/14
1.04
1.02
SPEED POINT
+
−
1.00
0.12
0.08
GROSS FOG
+
−
0.04

interpreted.

## LIMIT LINES

The upper and lower limit lines on a control chart are based on the assumption that the plotted points are representative of a normal "population" or set of circumstances. The limit lines, therefore, should include between them, all points representing an unchanged or normal or in-control process. Limit lines can never be placed in such a manner that all the data are included between them; *there will be deviations*. Samplings of a black and white process, for example, show a gamma average of 0.70. An estimate of the standard deviation is usually determined as 0.03. On a subsequent test, a sensitometric strip was found to have a gamma of 0.80. Obviously this process appears to have changed or is changing. Should the process be altered? The answer must consider the factor of probability.

There are two risks involved in judging whether normal limits are exceeded. One is that a certain sampling appears outside one or the other limit lines, indicating that the process is out of control, when actually the process may be behaving normally and has not changed. This situation is known as the alpha risk. The reverse is also possible: where it appears that the process measured is normal, when actually it has changed or is changing. This is called the beta risk. These occurrences cannot be eliminated but can be reduced to the point where the probability of their happening is small. One risk is usually more costly than the other and the limits are set accordingly. The limits are set far from the mean when the alpha risk must be avoided. They are set close to the mean when the beta risk must be avoided.

A good way to calculate the placement of the limits is to use a factor of three times the standard deviation, or $\pm 3s$. The alpha risk is approximately 3 in 1000 for limits of $\pm 3s$. Before proceeding, it is necessary to define the two following terms:

- Population—all recorded results (happenings) in a certain process.

ing ways:

- *The range of the set of numbers*—the difference between the largest and smallest numbers of the set.

- *Deviation*—the amount each element of the population is different from the mean or sigma—the standard deviation from the mean, calculated by adding the squares of each deviation and taking the square root of the sum.

- *Standard error*—the average percent deviation from the mean.

- *Standard*—an objective or an acceptable process used as a reference (comparison).

## CONTROL CHART INTERPRETATION

Control charts for film processing should be maintained as long as the process is in operation. You should remember the following guidelines if your control charts are to be of value and worthwhile:

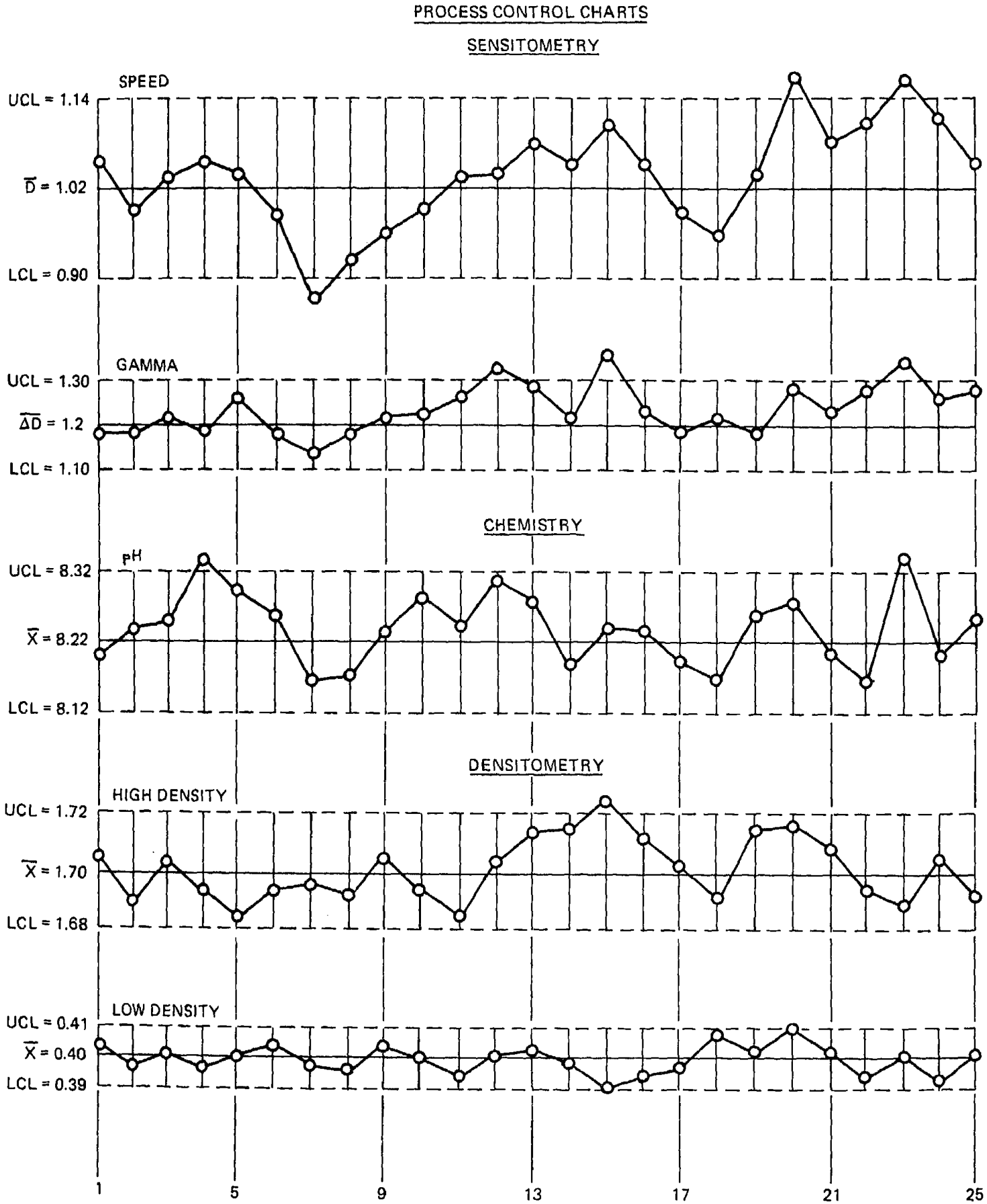
- There must be a continuous analysis of a statistical nature of photo processing control charts.

- It is pointless to maintain control charts, then fail to act when the chart indicates a problem in the process.

- Control charts let you visually determine a definite processing problem occurring among random process variations.

- There is a certain amount of variability in a process over which you have less than absolute control.

- There can be overcontrol as well as undercontrol in precision quality assurance processing. This is needlessly expensive.


PROCESS CONTROL CHARTS
SENSITOMETRY
SPEED
UCL = 1.14
$\overline{D}$ = 1.02
LCL = 0.90
GAMMA
UCL = 1.30
$\overline{\Delta D}$ = 1.2
LCL = 1.10
CHEMISTRY
pH
UCL = 8.32
$\overline{X}$ = 8.22
LCL = 8.12
DENSITOMETRY
HIGH DENSITY
UCL = 1.72
$\overline{X}$ = 1.70
LCL = 1.68
LOW DENSITY
UCL = 0.41
$\overline{X}$ = 0.40
LCL = 0.39
1
5
9
13
17
21
25

maintain can illustrate five possible conditions of that process. These conditions depend upon any variations within that process. These five conditions are:

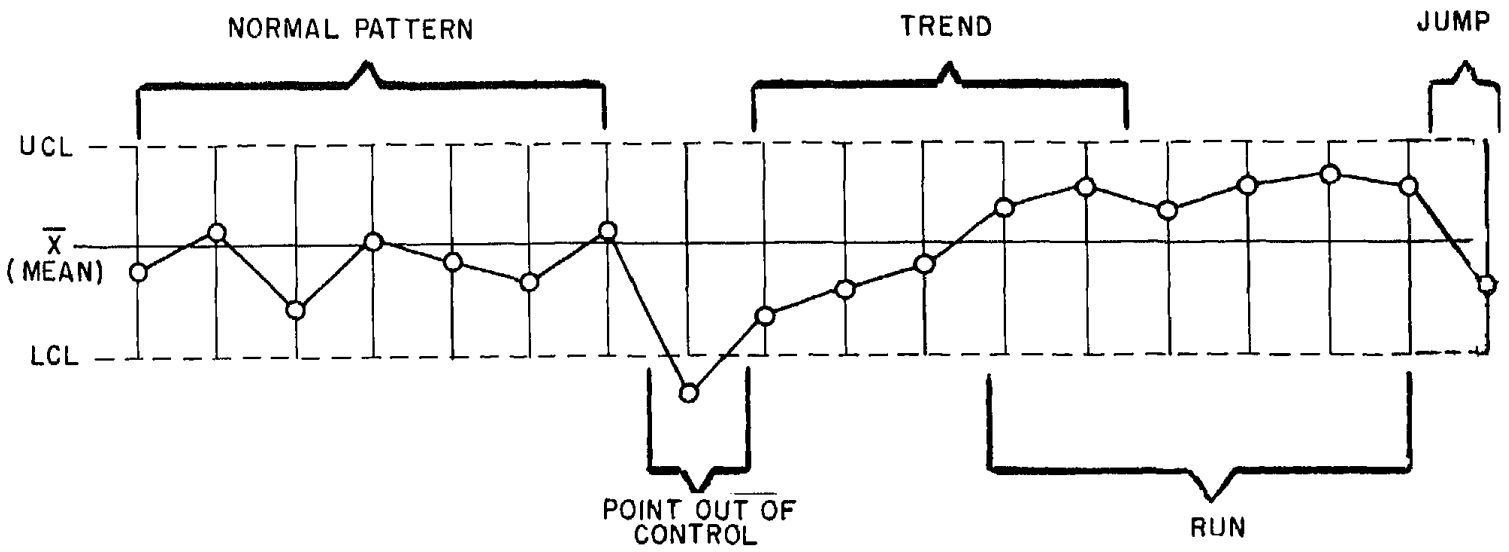
- Normal or random pattern
- Out-of-control point
- Trend
- Run
- Jump

If an out-of-control condition exists, immediate action should be taken to correct the problem. When the chart indicates a trend in five successive recordings, this is good evidence that the process is changing and needs investigation and possible corrective action. A run is when five successive recordings appear above or below the mean line. This also requires investigation and possible corrective action. A jump may indicate problems exist which need correction before the process goes out of control.

To be useful, a control chart must be accurate and analyzed at least daily.

PLOT PATTERNS.—Plots or points on a control chart should be thought of as patterns or groups and not as individual points. It is not enough to know where a plot is, you must also know how it got there. In process monitoring you must be able to recognize patterns that indicate a process is moving toward an out-of-control condition, or is out of control. After a value is plotted on a chart, the point is connected to the next previous point with a straight line. This provides a graphic picture of variations in the process and whether the desired or standard processing conditions are being maintained.

Trends.—A drift of plotted points either upward or downward, away from the established mean, with no sudden change in direction is called a *trend pattern*. A trend usually consists of at least five plotted points. An upward or downward trend usually indicates over- or underdevelopment, respectively. The processed images will be either increasing or decreasing in both density and contrast. A trend which is gradual may be an indication of too much or too little replenishment.



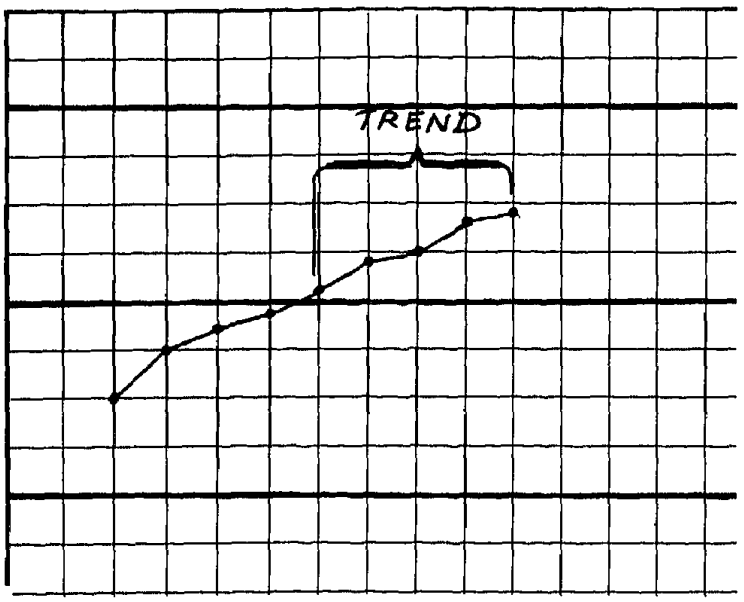

**Control chart interpretation.**

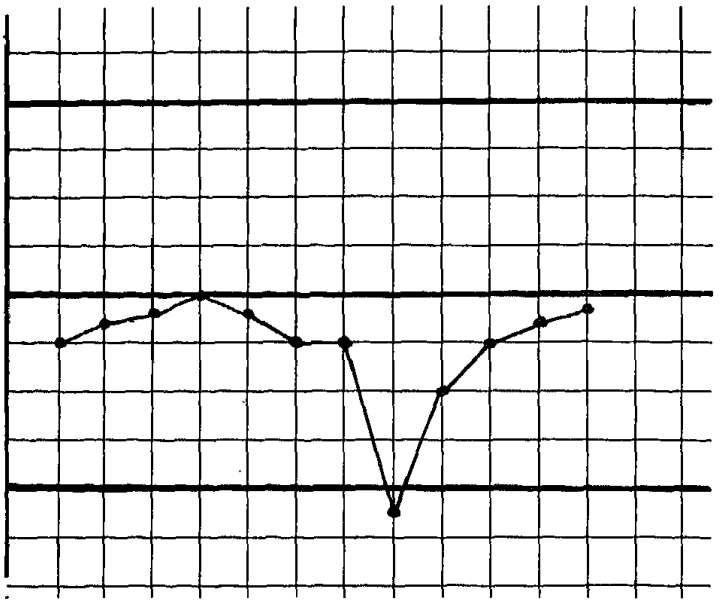
Jumps.—A plot point that jumps or suddenly moves away from previously plotted points may be caused by contamination of the chemistry, improperly mixed chemicals, or mechanical breakdowns such as replenisher systems or thermostats. A jump pattern is likely to occur after a process has been shut down, especially if the process has not reached the proper temperature.

Random.—Whereas trends and jumps must be analyzed to determine their probable cause, and corrective action taken—when necessary, a random pattern within control limits indicates that the process is in control and is not moving toward an out-of-control condition. When an in-control random pattern is maintained, solution strength is probably normal and no correction is necessary. However, when a random pattern includes a run, the process may need corrective action.

CORRECT DIAGNOSIS.—Sometimes two or more things may go wrong with a process at the same time and sometimes it won't be clear which of several probable causes is resulting in trend or jump or run patterns. In cases such as this, each of the probable causes must be investigated until the cause or causes of the undesirable condition are found and eliminated.

When there is more than one probable cause, the method of investigation, or the sequence of corrections should be based on the ease of checking and changing, economy of changing, and likelihood of happening. In other words, start your investigation with the easiest to find, most economical to correct, and most likely cause.



**Jump.**

When there is a sudden jump in the plot, look for factors which occur rapidly such as chemical contamination, temperature change, machine speed change, etc.

When a plot falls outside of the upper or lower control limits, follow the steps given here, in the order given, until you find the cause and correct it.

1. Check the appropriate instrument, such as the sensitometer, densitometer, pH meter, hydrometer, etc., to be sure it is calibrated and being used correctly.
2. Reread the sensi-strip or control strip densities or the pH or specific gravity to eliminate reading error as a cause of out-of-control plots.
3. Recheck the calculations and the plotting of the values.
4. Review the chemical mixing and/or replenishment records to determine if a discrepancy is evident.
5. Check to make sure the processing temperature, agitation, and times are correct.
6. Prove or disprove the value of a questionable out-of-control plot by immediately exposing and/or processing, reading and plotting

appropriate. This serves to eliminate the possibility of one improperly exposed, processed, or handled strip, etc., from indicating a problem in an otherwise satisfactory process. If the values of this second reading are within limits then you can assume that the first or out-of-control value was the result of irregular or random conditions, and resume processing. On the other hand, if the second reading also gives an out-of-control value, shut down the process until the problem has been found and corrected.

Monitoring B&W film processing is not difficult. A good quality assurance program which relies heavily upon process monitoring can enable you to:

- Detect troubles before they become serious or even prevent them.
- Maintain a continuous record of the process.
- Establish correct replenishment rates.
- Eliminate processing variables.

## FILM PROCESS RECORDS

One of the first steps in process monitoring is keeping an accurate record of the process in question. The process record should include any factors which may affect the process, including developer temperature, amount of film processed, amount of replenisher added, the person who

| DATE | DEV. TEMP. | TOTAL AMOUNT OF FILM PROCESSED SINCE SOLUTION (S) MIXED | | | REPLENISHER ADDED | | | | CONDITION | | CONTROL or SENSI-STRIP NUMBER and COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DEVELOPER | STOP BATH | FIX. BATH | DEV. | STOP BATH | FIX. BATH A | FIX. BATH B | S.B. | FIX. | |
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| | | | | | | | | | | | |

Machine or Process:

Developer:
Developer Replenisher:
Developer Replenisher Rate:

Stop Bath:
Stop Bath Replenisher Rate:

Fixer:
Fixer Replenisher:
Fixer Replenisher Rate:

you will be able to establish and maintain proper replenishment rates and provide a check on the process so that factors which affect processing quality can be recorded. When sensi-strips indicate that the process is, or is going, out of control, some potential causes may be eliminated by checking the processing record. This often makes it possible for you to determine the real source of trouble more quickly. Also, when your workers are required to maintain a processing record they have an added incentive to follow prescribed procedures more carefully.

sheet or roll, film or paper, processed by machine or by hand.

Notice in the next example of the process record that in the "Total Film Processed" columns, the amount of film processed in each solution is cumulative. That is, the numbers shown always indicate the total amount of film processed since the solution was new. This example is just that—an example—don't use the data given to establish your processing standards; such as replenishment rates, or the amount of film which can be processed, etc.

In any quality assurance program it is always easier to prevent problems than to correct them after they occur. When the following steps are taken, problems in processing will be eliminated or at least reduced to a minimum:

- Store chemicals as recommended by the manufacturer.
- Be mindful of effective chemical, working and shelf life. Remember, some chemicals may be subject to changes in their photographic qualities due to age, both on the shelf before mixing and as processing solutions.
- Make sure mixing, storage, and processing equipment is constructed of materials which will not affect or be affected by photographic chemicals or solutions.
- Use the purest water possible to prepare solutions and to wash materials.
- Filter water when necessary.
- Label all solution storage and processing tanks.
- Avoid solution contamination.
- Check the volumes of chemical mixing tanks and other processing equipment.
- Check the accuracy of scales, thermometers, hydrometers, pH meters, densitometers, etc.
- Follow prescribed chemical mixing techniques, methods, formulas, and directions.
- Protect solutions with floating lids and/or dust covers.
- Use only proper film and processing techniques.
- Use recommended replenishment rates.
- Use recommended processing times.
- Use recommended processing temperatures.
- Use correct agitation.
- Use proper washing procedures.
- Dry film correctly.

steps to correct any problems thus avoiding any delays in processing production work at the beginning of the next work period.

## COLOR PROCESS MONITORING

Much of what has been discussed about quality assurance in previous paragraphs can be carried over to understanding color quality assurance. However, color processing quality assurance is more critical than QA used for conventional black and white films—particularly since the color balance must be considered.

on a graph.

In color sensitometry, the first requirement of the sensitometric exposure is that the exposure be about the same as found in the actual subject exposure. Because of the complex structure of color emulsions, the variability of the dyes and color formers or couplers, and the vast number of spectral energy distributions present in the scene being photographed, it is difficult for you to measure, much less control, all of the parameters of color reproduction. Therefore, to be practical, sensitometric evaluation of color materials is based upon gray-scale exposures. Such exposures are made by using sensitometers designed specifically for the purpose or by black and white sensitometers that have been modified.

| DATE | DEV. TEMP. | TOTAL AMOUNT OF FILM PROCESSED SINCE SOLUTION(S) MIXED | | | REPLENISHER ADDED | | | | CONDITION | | CONTROL or SENSI-STRIP NUMBER and COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DEVELOPER | STOP BATH | FIX. BATH | DEV. | STOP BATH | FIX. BATH A | FIX. BATH B | S.S. | FIX. | |
| — | — | 4X5 / 8X10 | 4X5 / 8X10 | 4X5 / 8X10 | 1 OZ PER 8X10 | 5 OZ PER 150 8X10 | 10 OZ PER 150 8X10 | 5 OZ PER 150 8X10 | — | — | |
| 2/8 | 70°F | 150 - | 150 - | 150 - | ✓ | ✓ | ✓ | ✓ | OK | OK | 01, 02, 03 |
| 2/8 | 70°F | - 63 | - 63 | - 63 | ✓ | ✓ | ✓ | ✓ | OK | OK | 04, 05 |
| 2/11 | 70°F | 275 71 | 275 71 | 275 71 | ✓ | ✓ | ✓ | ✓ | OK | OK | 06, 07, 08, 09 |
| 2/12 | 70°F | 375 - | 375 - | 375 - | ✓ | ✓ | ✓ | ✓ | OK | ? | 10, 11. SB NG |
| 2/14 | 70°F | 425 150 | 425 150 | 425 150 | ✓ | ✓ | ✓ | ✓ | N/G | OK | 12, 13, 14 |
| 2/17 | 70°F | — — | NEW | | | | | | OK | OK | 15 |
| 2/18 | 71°F | 575 150 | 150 - | 577 150 | ✓ | ✓ | ✓ | ✓ | OK | OK | 16, 17, 18 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Machine or Process: HAND PROCESS DARK ROOM NO. 3

Developer: D-76
Developer Replenisher: R-76
Developer Replenisher Rate: 1 OZ PER 8X10

Stop Bath: KODAK INDICATOR SB
Stop Bath Replenisher Rate: 20 OZ PER 150 8X10

Fixer: F-5
Fixer Replenisher: F-5
Fixer Replenisher Rate: 20 OZ PER 150 8X10(A); 5 OZ PER 150 8X10(B)

*on page 2-46 and ending after "Action to Take When Control Limits are Exceeded," on page 2-53 is, in part, derived from* **Eastman Kodak** *Publication No. Z-99, "Introduction to Color Process Monitoring," second edition, first 1980 printing. Express permission to use this copyrighted material has been obtained from* **Eastman Kodak** Company, Rochester, NY 14650.

## HOW A COLOR PROCESS IS MONITORED

A color process evaluation must include consistent monitoring of the process with control strips in order to establish a standard process and to correlate mechanical, chemical, and control strip information with photographic tests.

### Steps in Color Process Monitoring

The color process monitoring steps can be summarized as follows:

1. Measure the densities of the specified steps of the reference strip (a strip supplied with the control strips) and apply correction factors (if they are supplied) to establish reference values.
2. Process a control strip (usually with regular production film).
3. Measure the color densities of certain steps with a color densitometer.
4. Plot the difference from the reference values.
5. Interpret the plots. As long as they stay within predetermined tolerance lines, and the spread between the three color densities of any plot is within specific limits, the process is normal, standard, or in control. If the plots show a trend toward an out-of-control condition, or if they jump to an out-of-control condition, the plots are studied to find the probable cause of the situation.
6. Correct the process. Sometimes the interpretation will indicate clearly a simple probable cause. Sometimes it will not be clear which of two or three likely causes is the problem. Sometimes it will indicate that two or more things are going wrong at the same time. When more than one cause is indicated, a sequence of corrections must happening.
7. Follow up on the process change by repeating the above steps to make sure that the process has been corrected and is again in control.

The tools used in following this procedure are:

- Monitoring manuals
- Control strips and reference strips
- Densitometer equipped with color filters
- Control charts
- Processing records of mechanical and chemical variables

### Monitoring Manuals

Since the details of the monitoring procedure change somewhat with each of the many color processes, Kodak's monitoring manuals, or Z-series manuals, are necessary supplements to a color process monitoring system. The monitoring manuals describe the process, the specific control strip to be used, the steps to be read, the calculation of reference values and control values, specific plot patterns, and plot pattern interpretation.

### Control Strips

Kodak process control strips help you maintain a high-quality processing operation. They consist of precisely controlled exposures made on strips cut from a uniform piece of sensitized material. Each exposure level is called a "step," and it is often identified by a number. **Kodak Ektaprint** 2 Control Strips have light and dark steps of the three subtractive primary colors, whereas other control strips have a series of neutral density steps. Process monitoring relies primarily on the measurement of densities of the steps, which represent the subject tones in pictures. It has been found that if three of four key tones are monitored the process can be adequately controlled.

intermediate tones. Monitoring D-max is also desirable for reversal processes.

The relationship among the three color measurements of a step is often used to monitor color balance.

The difference in the readings from the two steps (HD-LD) provides measurements of red, green, and blue contrast. Sometimes this is used as a monitoring parameter as is the spread between the plotted points.

It is recommended that control strips be stored at 0 °F to minimize keeping changes. The strips have been stabilized, and an expiration date is often assigned in an attempt to provide a reliable tool with which to monitor processes. The strips should be removed from the freezer, one at a time, as they are needed.

A few control strips from each batch are processed by the manufacturer in a near-standard process, and one of the processed strips is included with each package of control strips. These processed strips, called reference strips, provide a means for a laboratory to determine a process standard in terms of its densitometer readings. By reading these strips and applying the correction factors indicated for each step, initial reference, mean, or aim values are determined for each step.

A few words of explanation about the determination of the desired standard level may be helpful. Periodically, Eastman Kodak Company surveys the sensitometric results being obtained by photofinishers in their film and paper processes (printer control is also surveyed). These data, after excluding certain extreme results, are averaged. The average is then used as a standard to determine what reference values are desirable for a code of control strips.

## Determining the Process Level

The first time color process monitoring is used, or the first time a process is started up, follow these steps:

1. Be sure that chemical and mechanical specifications are met.
2. Determine the initial reference values for the particular code of control strips for each density step specified in the appropriate Kodak monitoring manual. This generally consists of correction factors. It is desirable to average the results from several reference strips of the same batch, if available, to minimize the effects of variability.
3. Process one control strip in each of three different production runs. Always orient the strip the same way, that is, light-density end first in continuous machines and light-density end up in rack machines. Always place the strip in the same location to minimize variations caused by differences within a developer tank.
4. Read the red, green, and blue densities of the specified control strip density steps on the densitometer and average the values.
5. Subtract the initial reference values from the average densities to obtain the average control values. If a control parameter of high density minus low density is specified for the process, determine that also.
6. Tolerance limits are defined and prescribed in each of the Kodak monitoring manuals. If the average control values obtained in the preceding step fall within the tolerance limits for the process, production work may be processed and the initial reference values may be used to determine subsequent control values for that particular code of control strips.
7. If the average control values fall outside the tolerance limits, it is likely that there has been a mistake in reading the control strips, performing the calculations, setting up the densitometer, or starting up the process. If a recheck of these operations shows no error, there may be something wrong with the control strip, resulting from improper storage or handling. If possible, start over again with a new batch of control strips (and a new reference strip, of course).
8. When the source of the out-of-control condition is found and corrected, repeat this procedure.

For most color products, there is a variety of processing methods such as sinkline, rack-and-tank, and continuous, and these methods may be small or large, batch or replenished. In addition, processing may be frequent or infrequent. Somewhat different average process results will be obtained using the wide spectrum of process techniques. For this reason, and to accommodate the unavoidable variables in the control strips themselves, it is necessary to permit a small degree

### Limits and Tolerances

Once the mean or standard has been established, action and control limits are set in accordance with the appropriate monitoring manual. As you continue to plot control values, you will see a random variation around the process standard over which you have little control. As long as the control limits are not exceeded, acceptable quality can be expected. If a control strip shows that the control limits have been exceeded, confirm this with a second strip; then refer to the appropriate monitoring manual and shut down the process until the trouble has been corrected.

## PROCESSING CONTROL STRIPS

Once a process level has been established, control strips must be processed on a regular basis. Each color product has a particular control strip with a particular format. In a sinkline process, a control strip is processed with each run of production film because of human variables. In continuous (machine) processors, run a control strip:

- Before processing production work at the beginning of the workday or shift or after a long shutdown such as a weekend, holiday, breakdown, etc.

- Along with production work at various times throughout the day.

- Near the end of the workday or shift.

- After any chemical or mechanical change, and note the change on the control chart.

- Whenever fresh chemicals are used in the process. Make a note on the control chart.

- Whenever problems are suspected.

Be sure to handle and load unprocessed control strips in total darkness.

Control strips should always be processed with the D-min first in continuous processors. This end of rolls and with a dimple or notch impressed in the D-min end of individual strips. Procedures should be standardized so that the control strip is located on the same strand in multiple-strand line processors, and fed through the same side of the machine in roller-transport equipment. Even in sinklines the positioning should be consistent.

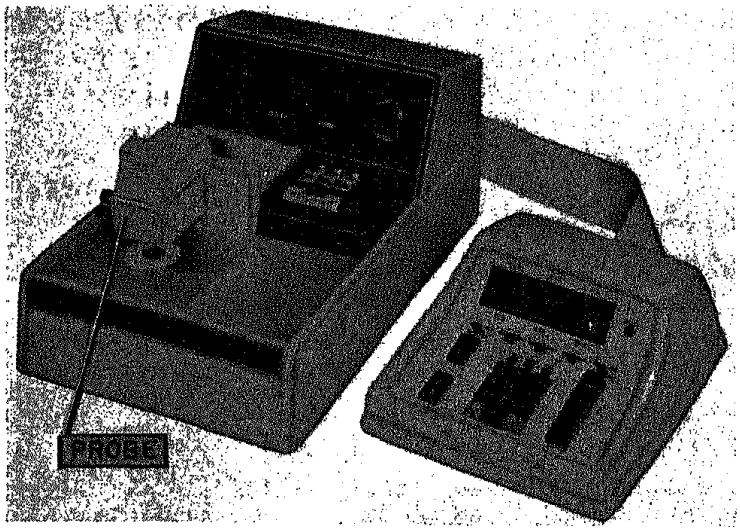
In continuous processors, the strip is spliced, D-min first, onto the trailing end of the leader if it is to be processed before production work. Otherwise, it is spliced on the trailing end of a production roll. As soon as a control strip comes out of the dryer, identify it with the time and date of processing. A code number identifying a machine or operator may also be desirable. Use a stick-on label for this purpose, and place it in an area that does not interfere with densitometer readings.

Always inspect a control strip before reading the appropriate densities so that physical or chemical defects can be noted and avoided during the measuring operation. Use the middle area of the density steps for obtaining the density readings, provided this area is undamaged. Make each measurement twice, using a slightly different area of the step each time, and average the readings.

## DENSITOMETERS

It is obvious from the foregoing material that a densitometer is an essential tool in color process monitoring. To evaluate the processed control strips, the red, green, and blue densities of selected steps must be measured. This requires the use of an electronic densitometer equipped with the appropriate color filters; for example, Kodak Densitometer Filter Set AA (Certified) red, green, and blue for paper and reversal films and Kodak Densitometer Filter Set MM (Certified) for negative films. These filters are selected and calibrated to conform to extremely close spectral tolerances. Other filters, such as **Kodak Wratten** Filters No. 92 (red), No. 93 (green), and No. 94 (blue), can be used for accurate density measurements, but a certified set is necessary if two or more densitometers need to correspond to each other.

The densitometer must be of the transmission type for reading film densities and of the reflection type for reading paper densities. The




*Densichron Products/Sargent-Welch Scientific Co.*

**Color densitometer.**

manufacturers of various densitometers provide complete instructions for the use and care of their instruments.

## COLOR PROCESS CONTROL CHARTS

The data resulting from the use of control strips for color processing should be plotted on control charts. A warning, however: Its value as a record of the behavior of the process and its response to control activity focuses attention on the control chart. In a negative-positive color photographic system, this can lead to a gradual distortion of perspective until process control becomes a goal in and of itself rather than a tool to help in the production of high-quality prints. It is usually difficult to predict color quality from process control results. A good control program uses control charts *and* subjective print quality analysis in decision making. A control chart is essential, though, to avoid situations where a serious processing error is compensated for in printing in order for print quality to remain acceptable. A lab that is compensating for errors near or beyond the control limits is certain to have more quality problems when small variations occur than a lab operating near standard.

Preparing a control chart, such as the Kodak

2. Record the reference strip code number and the reference values in the appropriate places. It is helpful if colored pencils are used to distinguish the red, green, and blue densities when recording the reference values.

3. Draw horizontal lines to represent the mean or standard zone and action limits[1] and upper and lower control limits.

4. Record the process and machine number.

5. When plotting the control values, record the date and time that the control strip was processed and note any chemical or mechanical changes made as a result of the plots.

6. When changing to a new control strip code number, note it on the chart, with the date, and record the new reference values and limits.

7. Plot control values having a plus sign above the line that represents the reference value, and plot control values with a minus sign below the reference value line.

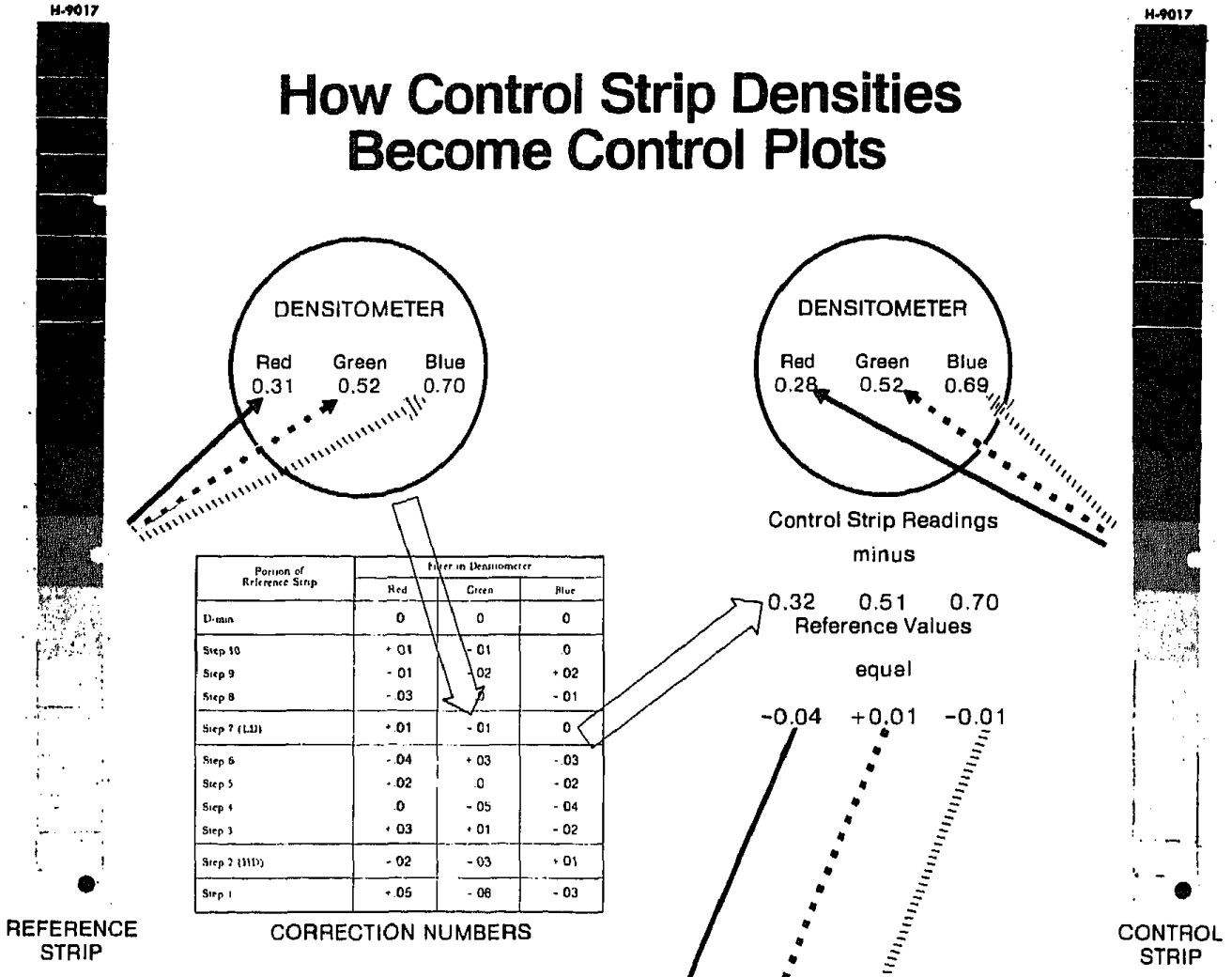
8. Connect the points to give a continuous graph.

*The control charts shown here are not intended to represent an actual control film or process. Their sole intent is to illustrate patterns that can occur on actual control charts.*

When control values plot within the action limits, no adjustments need to be made, since this places more emphasis on the control method than it justifies and constitutes overcontrol. If two successive plots exceed the action limits, steps should be taken to correct the difficulty. If successive plots exceed the control limits, the processing of production work must cease. However, it may be desirable to verify that the densitometer has not shifted; reread the reference strip and compare the values with those obtained originally.

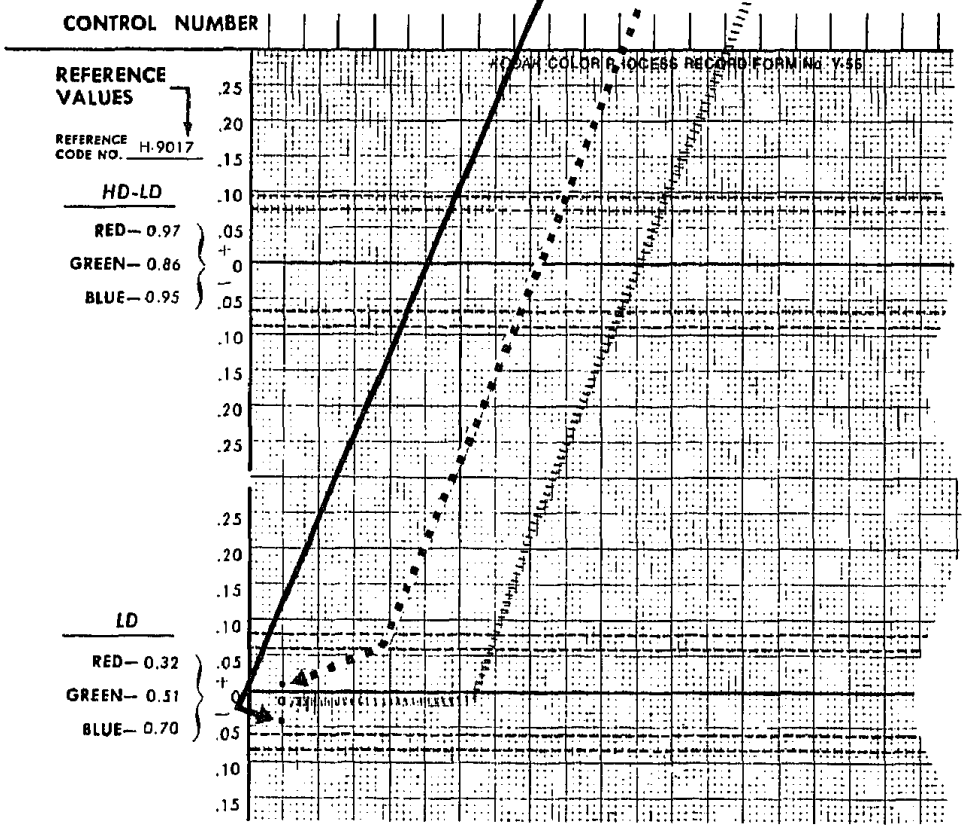
The emphasis in process monitoring is on densitometry. Keep in mind, however, that changes in the process are made by chemical and mechanical variations, intentional or not.

# How Control Strip Densities Become Control Plots




| Portion of Reference Strip | Filter in Densitometer | | |
|---|---|---|---|
| | Red | Green | Blue |
| D-min | 0 | 0 | 0 |
| Step 10 | + 01 | - 01 | 0 |
| Step 9 | - 01 | - 02 | + 02 |
| Step 8 | - 03 | 0 | - 01 |
| Step 7 (LD) | + 01 | - 01 | 0 |
| Step 6 | - 04 | + 03 | - 03 |
| Step 5 | - 02 | 0 | - 02 |
| Step 4 | 0 | - 05 | - 04 |
| Step 3 | + 03 | + 01 | - 02 |
| Step 2 (HD) | - 02 | - 03 | + 01 |
| Step 1 | + 05 | - 06 | - 03 |

CORRECTION NUMBERS



Problems are much easier to track down if records are kept of all intentional changes in:

- Machine speed
- Solution temperatures
- Flowmeter rates
- Agitation
- Filters
- Squeegee adjustments
- Parts (racks, gears, pumps, lines)
- Operators
- Processing solutions
- Replenishment rates
- Film types
- Bleach regeneration
- Silver recovery
- Control strips

### ATTRIBUTES OF A GOOD COLOR PROCESS

Control limits have been demonstrated to have good correlation with acceptable visual results. If trouble or poor quality is to be dealt with as soon as possible, a regular program of print or transparency inspection *must* supplement the monitoring effort. Visual quality of the final product and a precise knowledge of the mechanical and chemical condition of the process make the pattern of the control plots meaningful.

A good photographic process should have at least two quality attributes. First, it should exhibit low sensitometric variability on an hour-to-hour and day-to-day basis. This is considered "short-term" variability. The benefits of operating processes with low short-term variability are lower make-over (reshoot/reprint) rates, better print or transparency quality, and easier printing. The second attribute of a good process is that its average performance, measured sensitometrically, should be close to the standard specified by the manufacturer of the product being processed. Only when processes are operated near the standard level and with low short-term variability can the full potential of the photographic material be realized: the maximum yield of good transparencies

## Action to Take When Control Limits are Exceeded

In interpreting control value plots, the first consideration is whether a plot has exceeded the action limits or control limits. As long as the plots fluctuate within the action limits the process is running in control and generally should be left alone. If a red, green, or blue measurement exceeds the action or control limits, immediately process another control strip. If its results confirm those of the first strip, proceed as follows:

1. Before seeking a cause for the condition, make sure that:

- the densitometer is calibrated and operating properly. Then reread the reference and control strips to eliminate a reading error as a possible cause.

- the reference strip and control strip have the same code number.

- the control strips were stored and handled properly.

2. If the *action limits* are exceeded (where they are used): continue to run production work, but seek the cause of the action limit transgression situation and correct it. Be sure to note the corrective action on the control chart.

3. If the *control limits* are exceeded: cease to process production work. Run no production work until the cause of the out-of-control condition has been found and corrected. Process a control strip to verify that the corrective action taken had the desired effect and note the action on the control chart.

Processing trends and tendencies are not as well defined as control values, but they are equally important. These conditions in the process indicate unnecessary bias or drifts away from standard, as well as a degradation of processing quality. For example, if successive plots of control values show that an increasing number of densities are moving away from standard in a particular direction, corrective action may be taken to stop or reverse the trend before plots have

undesirable. These processing tendencies use up part of the operating tolerance if they remain uncorrected.

An out-of-control situation is serious; therefore, it is important that the information indicating such a condition is correct. If the out-of-control condition is verified by a second control strip, it must be considered real. Two consecutive control strips seldom provide similar false information about a process.

In the negative-positive color photographic system, the processing of the film and paper is only half the operation of producing a picture. Printing the negative onto the sensitized paper is the other important element, and it must be carefully controlled. Monitoring the performance of color printers is the subject of another Kodak Publication, No. Z-500, *Introduction to Color Printer Control for Photofinishers Using Non-computerized Printers.* It is mentioned here, because processing and printing interact. Often a printer adjustment is made to improve picture quality when, in fact, it is the film or paper process that needs attention. Only by monitoring each stage of production—film processing, printing, and paper processing—can the true cause of unacceptable results be isolated quickly. To make a change in a part of the system that is not contributing to the unsatisfactory results is to add another out-of-control situation to the one that already exists.

Each of Kodak's Z-series manuals has a section devoted to possible causes of processing problems and what they look like on a control chart. Some charts show neither patterns nor quantitative data, but give all the possible ways each constituent can affect the film and what direction the effect will take. The specific monitoring manual for each process also includes verbal descriptions of problems and lists possible solutions.

When a process problem gives a clearly identifiable cause, the correction is usually quite simple. When the interpretation indicates a simple cause, but cannot distinguish between several possible causes, a sequence of checking is needed to locate the cause:

1. Check the indicated cause that is easiest to

2. Check the indicated cause that is most economical to correct. If there are two possible causes and one of them involves dumping a tank of costly color developer, check the other possible cause first. If it turns out the tank must be dumped after all, at least it can then be done with the assurance that it was necessary.

3. Check the indicated cause that is most likely to happen. Some problems occur frequently; others, very rarely. After some experience with a process, knowledge is gained about which things go wrong most often. This can be determined by examining your control plot records.

4. One of the last things that should be done when trouble is found is to dump a solution. This is because a processing tank may contain many gallons of solution; therefore it becomes very expensive to dump solutions. An easy and economical way to determine if a processing solution is bad and must be dumped is to use a *bypass test*. This involves processing a control strip in a freshly mixed, small quantity of the same type of solution that is suspected to be causing trouble. A 1-pint kit is ideal for this purpose. In practice, the control strip is processed in the normal manner in whatever equipment is being used up to the solution that is suspect. The control strip is then removed from the equipment and transferred to the fresh solution (in the dark, if darkness is required at that step in the normal process). A graduated cylinder or a beaker makes a good container for the fresh solution. Keep the strip in the fresh solution for the required length of time, agitating it by moving it up and down gently. Then return the strip to the normal processing equipment for completion of the process.

5. Once it appears that the cause has been found and a correction made, run a control strip to be sure that the process is back in control. It may be necessary to take more than one corrective action and to process more than one control strip. When the process has returned to normal, plot the control values of the strips used to check the corrective actions and note the action taken on the control chart for future reference.

In this chapter, we have attempted to make the fundamentals of sensitometry and process

Unquestionably, experience is essential in finding the causes of an out-of-control process.

The principles of photographic densitometry, including the construction of sensitometric curves, are explained in Kodak Publication No. E-59, *Practical Densitometry*, a copy of which can be obtained, for a fee, by writing Eastman Kodak Company, Department 412-L, Rochester, NY 14650.

## PHYSICAL QUALITY

The quality assurance and monitoring methods we discussed stressed the sensitometric aspects, because they are quite complex. Physical quality, however, is equally important, and it is good practice to monitor it, along with image quality, by a methodical examination of control strips and finished work. The appearance of scratches, digs, spots, or streaks indicates mechanical malfunctioning somewhere in the processing cycle. In many cases, the causes of these defects are self-evident, and often the bypass test described above can isolate a malfunction.

## MECHANICAL CONTROLS IN QUALITY ASSURANCE

Finally, the mechanical factors involved in the photographic procedure should not be overlooked.

There are too many photographers who feel that when they expose a film for 1/50 second at f/8, the camera shutter opens and closes in 1/50 second and the lens transmits the light intensity that f/8 mathematically transmits. The shutters of very few cameras expose precisely for the length of time indicated on their shutter speed rings. Also, lenses seldom transmit the exact amount of light the f/stop setting indicates they should.

When you are using an exposure meter for determining exposure, does the reading obtained truly indicate the accuracy of the exposure meter? Make a test of this with any two meters in the laboratory. There will possibly be a variance of as much as a full f/stop's difference between these two meters, even though they are the same type.

Before you use a camera system for production work you should completely check out the camera system under all the conditions of available light, daylight, flash, and artificial lighting you may encounter in your work. As a result of these tests, you can be assured of proper exposure under varying conditions and better understand the characteristics of your camera, film, and meter.

Suppose you are assigned to the shooting crew of the photo lab. Under lab policy you are issued a camera set, exposure meter, and flash unit. To determine the characteristics of your equipment, load the camera with the type of film you will use for most of your assignments. Set the ISO number of this film into your meter. Next make a series of test exposures under various conditions that may be expected. For daylight exposures, shoot an exposure at the setting the exposure meter indicates. Shoot another exposure at one f/stop greater than indicated by the meter, and still another at two f/stops greater than indicated. Then shoot one exposure at one f/stop decrease from that indicated by the meter, another at two f/stops decrease. Finally, process these films to the gamma or contrast index the lab has set as standard.

After you process the negatives, make a print of each with a No. 2 variable contrast paper printing filter. The negative that renders the best print is selected as the one given the proper exposure. If the best print was made from the negative that was given a one f/stop increase over the meter indication, then you can say with reasonable certainty that your meter will render a one f/stop underexposure consistently—under daylight conditions. To correct for this variation, the film speed rating should be decreased one-half on the meter setting. Compensation for the underexposure conditions will then be automatic.

The same procedure should be carried out using the flash unit. The procedure is the same, except that any variation in exposure may be made automatically by altering the guide number the correct amount instead of the film speed rating.

With the exposure system checked and corrected, you know in advance the results your camera system gives under all conditions. You are free to concentrate on lighting, posing, timing, and other aspects, rather than being faced with the constant worry of correcting exposure.

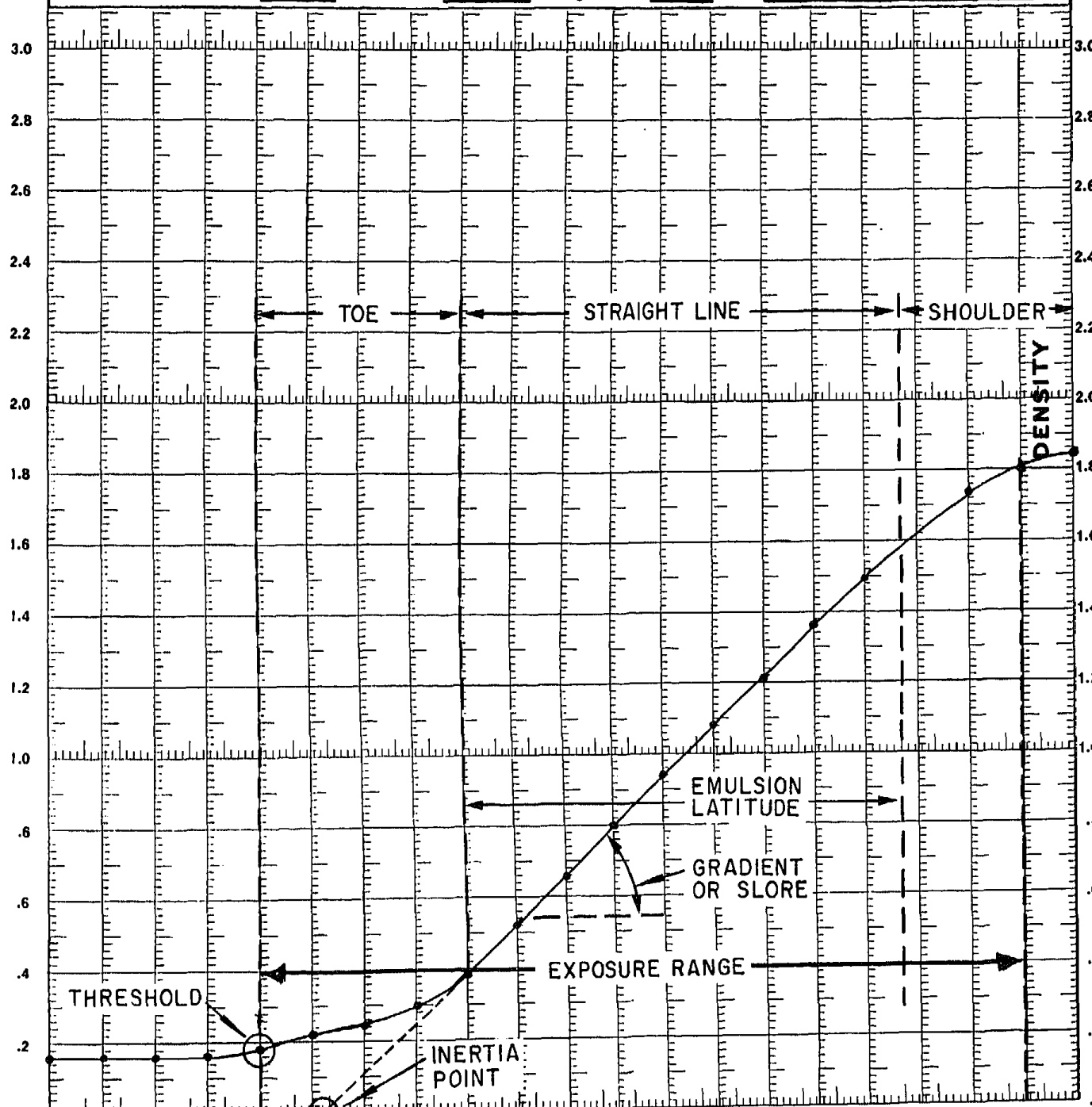
Strip No. 1 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 2 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 3 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Strip No. 4 — Devlpr._____ Temp._____ Dev. Time_____ Agitation_____ Gamma_____

Densitometer No._____ Date Read_____ Project No._____ Name_____



# CHAPTER 3

# TACTICAL AIR PHOTOGRAPHIC RECONNAISSANCE

Since the beginning of time when people banded together for protection against an enemy, the necessity of obtaining information about the enemy has been recognized. Information about an enemy could be gained more quickly by observers on some high place. Today, the situation is basically the same, with reconnaissance aircraft getting the information about an enemy's activities and strengths.

Modern tactical aerial photographic reconnaissance is an outgrowth of observation aviation which was the primary mission of the Navy airman during World War I.

During World War II, the techniques of aerial photography continued to be refined. It is estimated that most of the intelligence about our enemies during the war was gained through the use of aerial photography.

Since World War II the Navy has continued to improve its photographic reconnaissance capability with the development of aerial cameras having improved optics, higher recycle rates, and image motion compensation. These cameras have been mounted in high performance jet aircraft which serve as camera platforms. Keeping pace with improvements has seen the development of high-speed processors and printers and automated photo interpretation readout equipment. This improved equipment makes it possible for fleet commanders to have intelligence information with a high order of accuracy in a very short time.

During periods of heightened international tension, U.S. Navy carrier battle groups (CBGs) are deployed to strategic areas throughout the world in support of United States interests. Because such periods generally create instability in the areas affected, future developments are uncertain and extremely difficult to predict. Such circumstances and conditions clearly demonstrate the urgent need for the flexible response option provided by naval forces capable of rapid deployment and independent operations in an unfriendly environment, often at great distances from support activities.

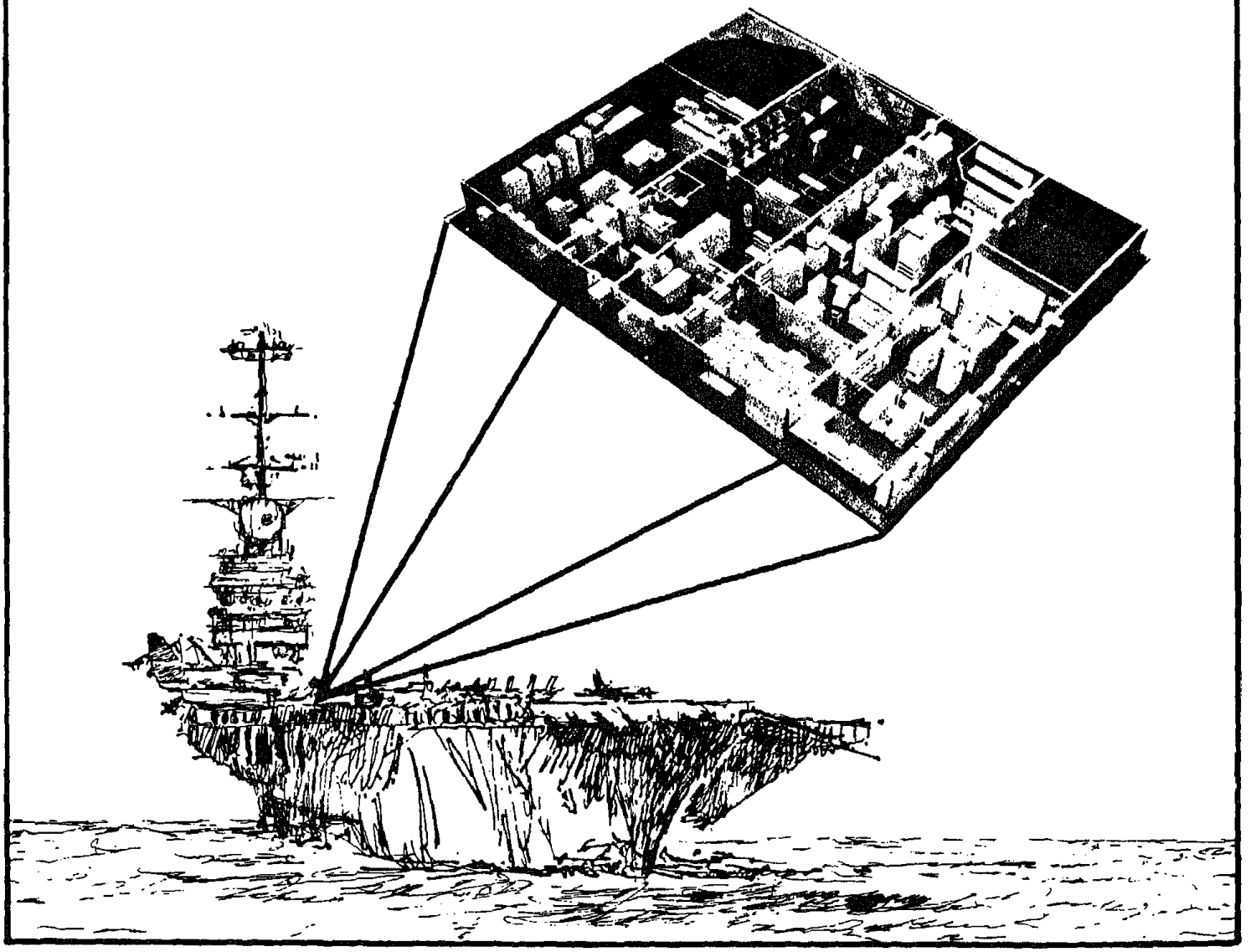
The series of incidents during a deployment of U.S. Naval Forces in the Mediterranean, near the Gulf of Sidra, for example, reemphasizes the need for constant vigilance and instant readiness. Offensive actions which threaten our Navy or restrict freedom of the seas may occur with little or no warning. In these potentially hostile environments, tactical air reconnaissance is the primary means by which a naval commander retains current surveillance of his surroundings, and maximizes fleet offensive capabilities and survivability. Therefore, the reconnaissance mission must, in such scenarios, be timely, effective, and responsive to the particular operational situation. Navy tactical air reconnaissance provides this mission flexibility.

At the time of this writing, the Navy's newest tactical air photographic reconnaissance capability lies in the Tactical Air Reconnaissance Pod System (TARPS).

TARPS was developed in response to the continuing needs of the operational commanders for accurate, timely, and usable reconnaissance-derived intelligence data for a variety of tactical situations.

TARPS is the airborne image collection system which consists of airborne photographic and

# F-14A/TARPS/CVIC



Tactical reconnaissance system.

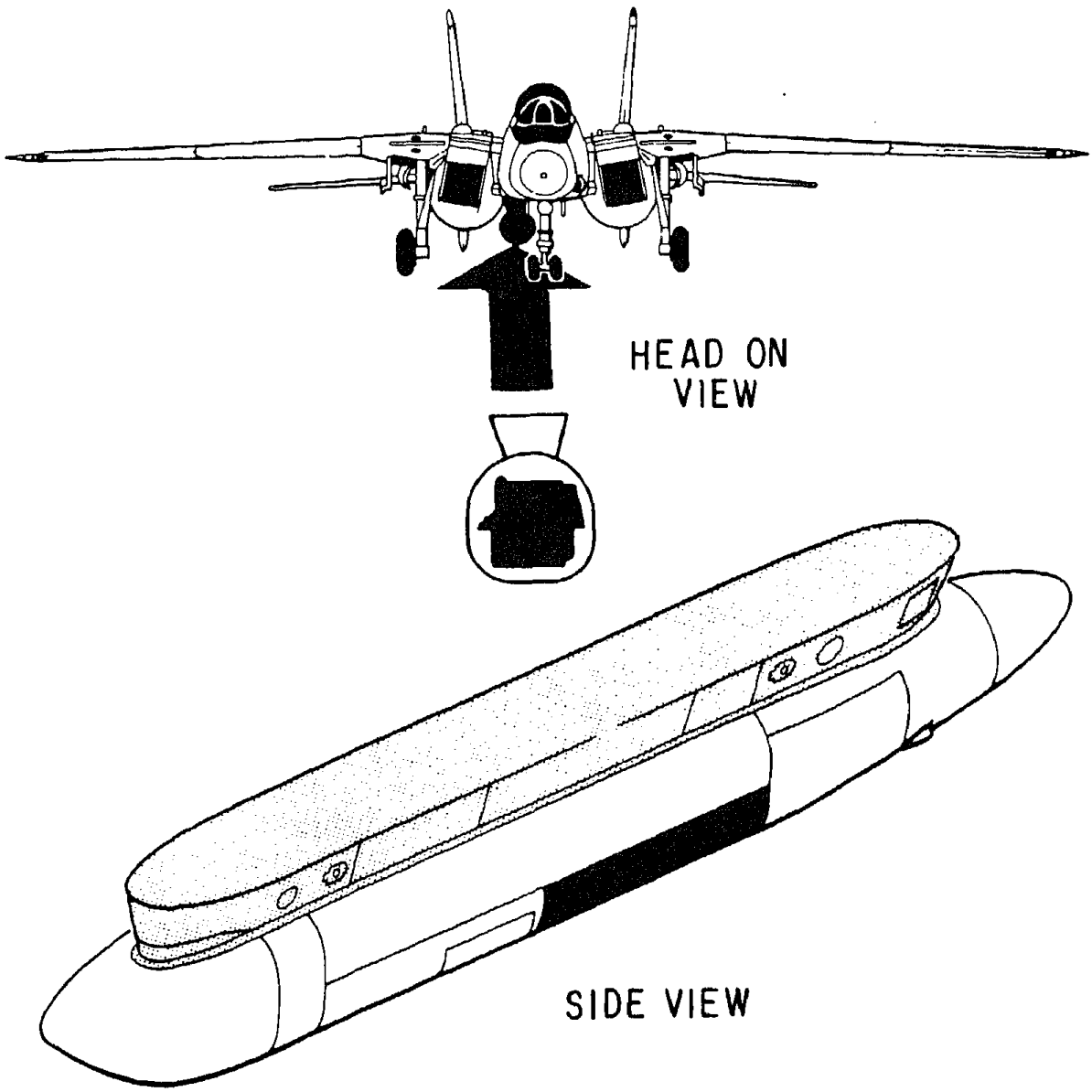
infrared image-forming sensors and associated equipment contained in a pod designed and built to be carried by the F-14A aircraft.

TARPS, when fully configured for the tactical reconnaissance function, contains two photographic sensors (cameras), an infrared reconnaissance set (IRRS), the electronics required to operate the cameras and IRRS, and auxiliary equipment to support the system.

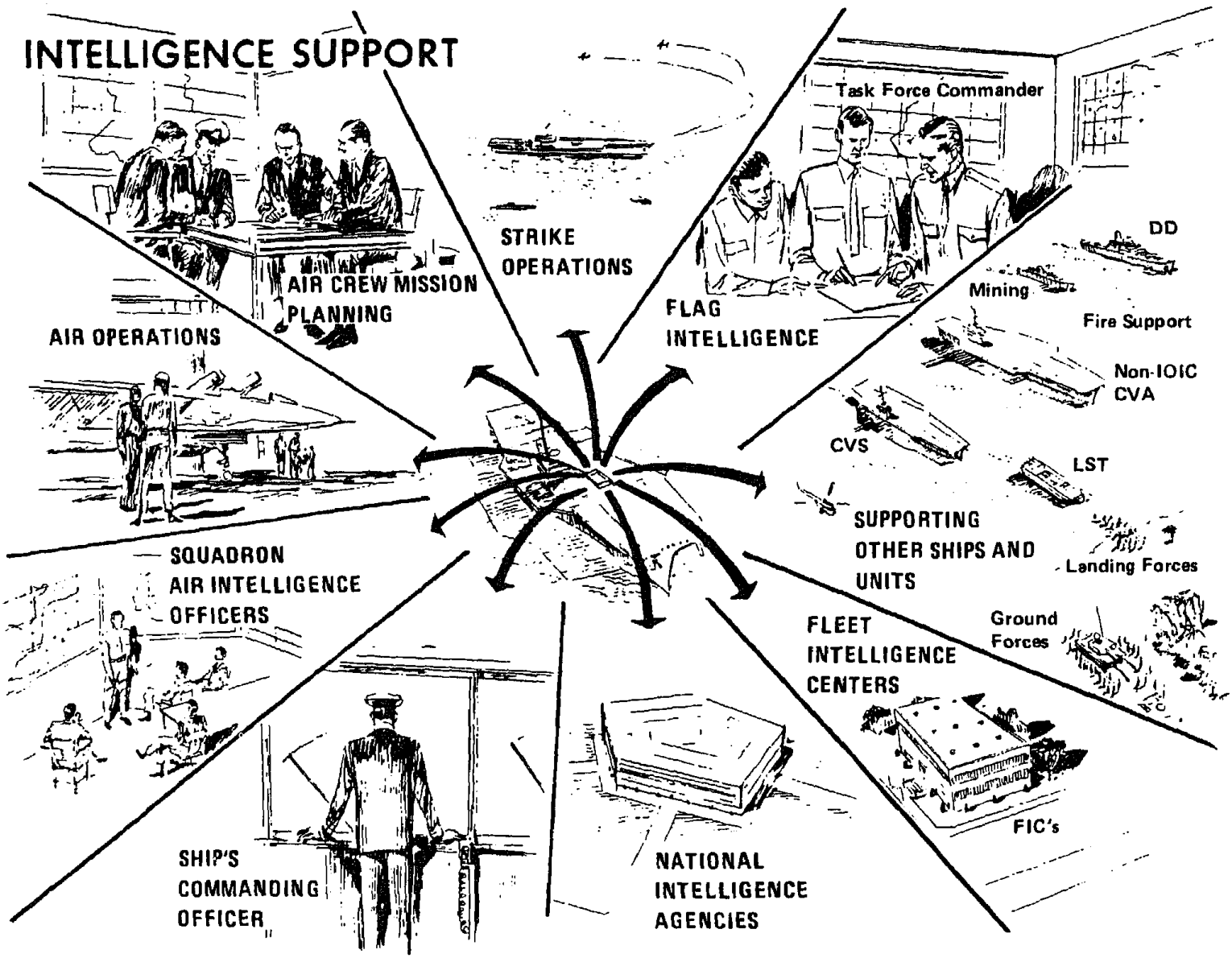
Primary day photography from horizon to horizon is accomplished using a panoramic camera. Additional day photography in the vertical of forward oblique mode is accomplished using a serial frame camera. Both day and night reconnaissance can be accomplished using the infrared reconnaissance set.

TARPS is supported by the Carrier-Based Intelligence Center (CVIC) which is an operational intelligence center designed and developed to process, analyze, and correlate intelligence data from a variety of reconnaissance techniques.

Tactical reconnaissance requirements are received from various levels of command and in various forms including Special Intelligence




**F-14A TARPS.**




**Intelligence support offered by TARPS/CVIC.**

Collections Requirements (SICRs), Naval Intelligence Collections Requirements (NICRs), and Essential Elements of Information (EEIs).

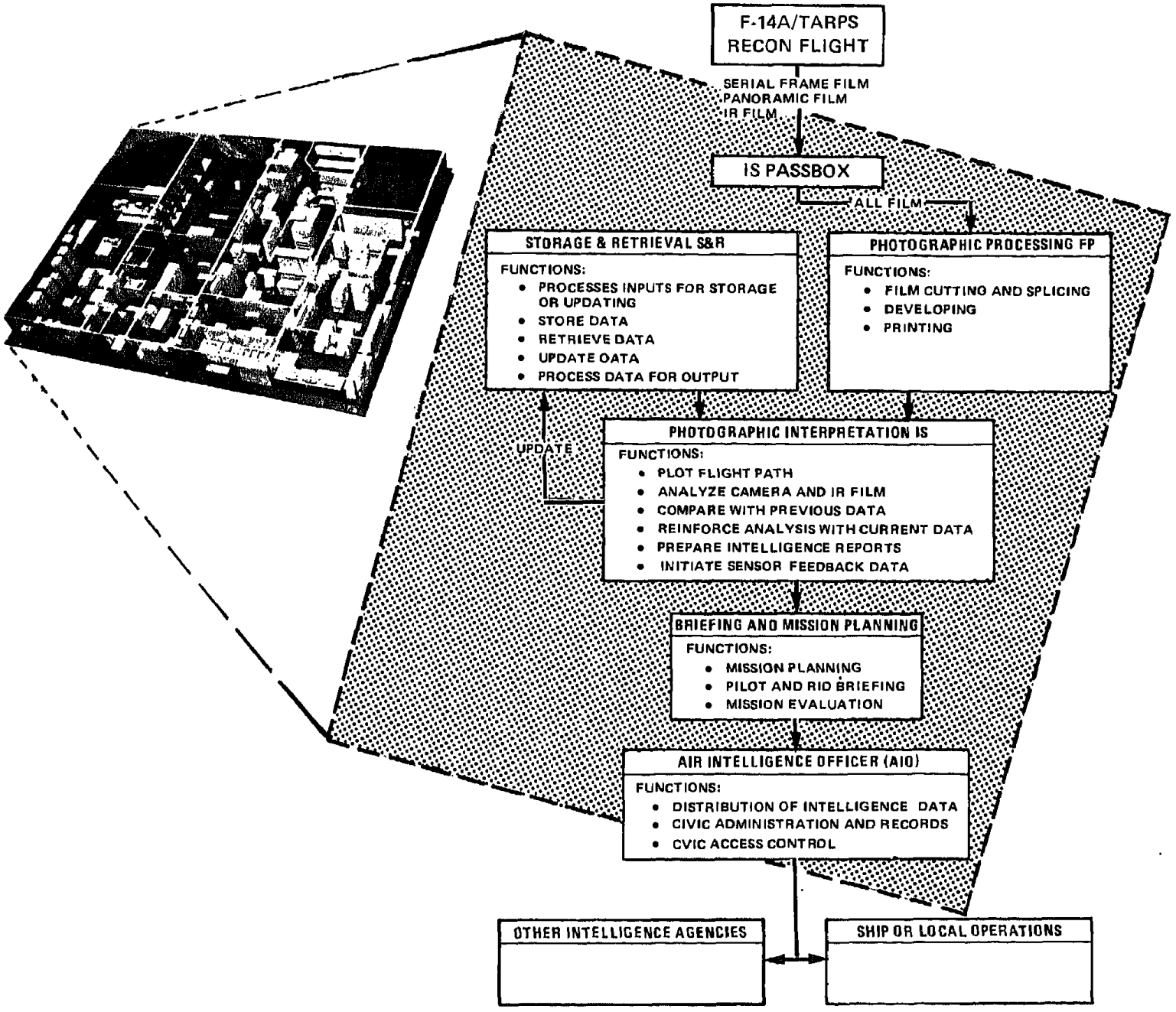
EEIs are normally originated by the task force commander or embarked flag, or they may be derived from operational orders set forth by the task force commander and directed by the carrier air wing (CAW) commander.

The requirements for any reconnaissance (recon) mission are generally passed from the CAW to the reconnaissance squadrons, where flight crews and others are assigned for planning and carrying out a mission which will meet the recon objectives.

CVIC, which is an operational facility aboard CV class Navy ships, provides support required to effectively accomplish the reconnaissance mission. The support provided by the CVIC includes film processing, image analysis and interpretation, and dissemination of the resultant intelligence information to operational commanders for planning tactical operations.

## RECONNAISSANCE MISSION PLANNING

General recon mission planning considerations provide information to the planners about target




**CVIC functional block diagram-image-forming data flow.**

requirements, environmental influences, factors that may affect the mission, and resolution requirements for difficult levels of intelligence.

The Photographer's Mate will find there are numerous factors involved in the planning of an aerial photographic mission. The type of mission, the selection of equipment, and the amount of expendable material required play an important part in the successful planning of an aerial photographic mission. Also, wartime or peacetime will determine to a great extent the amount of planning needed. In addition to the factors listed above, wartime factors of enemy opposition, time over the target area, number of aircraft available, and weather conditions are definite influences in the planning of an aerial photographic mission.

The ultimate success of any aerial photographic mission is largely determined by the accuracy and thoroughness of permission planning and the degree of crew coordination.

Operational considerations of the mission are usually determined by a higher level planning team than the reconnaissance crew.

Successful mission completion is dependent on squadron aircraft maintenance proficiency, flight crew capability, CVIC performance, and thorough mission planning.

## RECONNAISSANCE MISSION PLANNING BOARD

To ensure that all facets and details of mission planning have been considered, it is necessary to establish a Mission Planning Board to plan, direct, and coordinate missions assigned to the recon squadrons. As a senior PH you may be assigned to the planning board in an advisory capacity.

In tasking the CVIC, intelligence requirements should be stated specifically with respect to area of coverage, desired list of targets, and/or identification of objects about which intelligence is required. The details of the mission such as sensor use, flight path, altitude, etc., should be established by the Mission Planning Board.

Normally, the Mission Planning Board will consist of the:

Operations Officer (chairman)

Squadron Air Intelligence Officer (AIO)

Reconnaissance Coordinator

CVIC supervisor (possibly a senior PH)

Cognizant CVIC personnel (possibly senior PHs)

Squadron operations and maintenance personnel

Flight crew (pilot and Radar Intercept Officer (RIO))

Other specialists deemed necessary depending on the scope of the mission and tactical environment

The success of the recon mission will be in direct proportion to the time and effort expended in the planning process. Therefore, as a member of the planning board, you can't take your duties lightly.

The Mission Planning Board will generally conduct its planning by following a preestablished Mission Planning Board Outline/Time Schedule. Several examples of excerpts from a Mission Planning Board Outline/Time Schedule are provided here. Those areas of the outline/schedule which are not shaded may be of particular interest to PHs.

## PHOTOGRAPHIC MISSION PLANNING CONSIDERATIONS

After receiving a reconnaissance mission requirement, the reconnaissance coordinator selects the sensors and configuration required for the mission, film type and quantity, filter requirements, S/C control settings (the selected position of the camera), and film processing parameters.

As the technical aspects of the mission are formulated, a mission planning form is initiated and forwarded to aircraft maintenance and CVIC personnel.

### Mission Planning Form

The mission planning form is a tool of communication between the reconnaissance coordinator, squadron maintenance personnel, and CVIC. The form is divided into three basic sections, or related areas, with respect to areas of responsibility: mission data, maintenance, and processing data.

MISSION DATA SECTION.—When the reconnaissance mission requirements have been established, it is necessary to select the sensor or group of sensors best suited to fulfill the requirements. After selection of the sensors, the appropriate sensor IDs and other pertinent information are entered on the form. The mission planning form is then forwarded to the aircraft maintenance and CVIC personnel. Although the data contained in the mission data section of the

# MISSION PLANNING BOARD OUTLINE/TIME SCHEDULE

| TIME (min) | EVENTS |
|---|---|
| START 00-03 | Chairman — Read tasking requirements and assign duties.<br><br>Chairman/Air Intelligence Officer/Electronic Evaluator — Determine EEIs (spot size, coverage requirements, frequency, power) within three minutes. |
| 03-10 | 1. Air Intelligence Officer/Electronic Evaluator — Plot target, obtain weather data, plot orders of battle, record products and reports requirements.<br><br>2. Reconnaissance Coordinator — Determine sensor capabilties, best sensor configuration, and film type<br><br>3. Flight Crew — Prepare chart of objective area, plot orders of battle, select tentative target approach. |
| 10-15 | 1. Electronic Evaluator — Brief on all orders of battle.<br><br>2. Air Intelligence Officer — Brief on rules of engagement, weather, topography, spot size and coverage requirements.<br><br>3. Reconnaissance Coordinator — Brief on availability of sensors (for both primary and backup/secondary aircraft/mission). Brief on sensors suitable to accomplish assigned tasks and recommend best sensor configuration. |
| 15-19 | Board — Discuss alternatives. |
| 19-20 | Chairman — Make final decision and announce to board. |
| 20-58 | Board — Complete detailed planning and report progess to Chairman for possible reassignment of duties. |
| 58-60 | Board — Provide Chairman with charts and other required information. |
| 60 STOP | Chairman — Summarize Exercise |

## CHAIRMAN CHECKLIST

### 1. TASKING

a. Target name _____

b. Location _____

c. Expected spot size/coverage _____

d. Items of interest _____

e. Target history _____

f. Note--if multiple targets, list priority and sequence. _____

### 2. EXPECTED AIRCRAFT AVAILABILITY

a. Primary _____

b. Backup/Secondary _____

### 3. ORDER OF BATTLE/THREAT

a. Primary _____

b. Secondary _____

c. Tertiary _____

d. Note--consider terrain masking and use of DECM. _____

### 4. WEATHER/TOPOGRAPHY

a. Launch point _____

b. Target _____

c. MINIMUMS acceptable at target _____

d. Recovery _____

e. Climatological considerations _____

f. Course of action in case of unexpected weather _____

### 5. END PRODUCTS REQUIRED

a. B&W--Neg___ Pos___ Dupe Neg___ Select prints _____

b. Color--Pos___ CDIR___ Neg___ Prints _____

c. Report--OP-1___ OP-4___ Hot photo___ Brief _____

d. Tape printouts _____

## 6. SENSORS NECESSARY TO COMPLETE REQUIREMENTS

a. Forward oblique _____

b. Vertical camera _____

c. Panoramic camera _____

d. Infrared _____

e. Other (film, etc.) _____

Note: Camera availability and proper operating procedures.

## 7. SUPPORT FORCES/POSITIONING/AVAILABILITY

a. Escort _____

b. MIGCAP _____

c. RESCAP _____

d. IRONHAND _____

e. JAMMER _____

f. Tanker _____

g. AEW _____

h. SAR _____

i. Reconnaissance _____

j. Spares _____

## 8. COORDINATION OF FRIENDLY FORCES

a. Controlling agencies _____

b. Concurrent strikes _____

c. Call signs/IFF procedures _____

d. Communications (IAW Air Wing TACNOTES) _____

## 9. GO/NO-GO/ABORT CRITERIA

a. Sensor failure _____

_____

_____

_____

b. DECM _____

c. Weather _____

d. Support Forces _____

e. SAR _____

f. Other _____

10. SERE FACTORS

a. Safe areas _____

b. Personal authenticators _____

c. Friendly forces _____

11. CHARTS

a. Distance/time _____

b. Altitude _____

c. Tanking _____

d. Target heading/sensor coverage _____

e. Speed

f. Avoid overflight of heavy order battle

12. MISSION PLANNING QUESTIONNAIRE (To be answered in the course of the summary)

a. What reconnaissance sensors were chosen for the primary and backup aircraft (if used)?

b. What were the major considerations in selecting sensors?

c. What spot size would you consider maximum allowable to fulfill the required EEIs?

d. What spot size do you expect to achieve with your imagery?

e. What is your programmed altitude (minimum, maximum and optimum)? Why?

f. What support forces were programmed, and what will their tactics be?

g. What will the reconnaissance aircraft's tactics be from coast in point to coast out point?

h. What weather transmission factor did the Reconnaissance Coordinator use in establishing exposure?

i. What is the calculated object scene brightness for the target area?

HIGH _____ AVERAGE _____ LOW _____

## RECONNAISSANCE COORDINATOR CHECKLIST

GENERAL. The Reconnaissance Coordinator assists the mission planning board by determining sensor capabilities, optimum sensor selection, and type of film for the assigned target(s). He is also cognizant of aircraft status and availability of aircraft sub-systems. Utilizing the publications and charts listed below, the Reconnaissance Coordinator will recommend to the board the sensor best suited to accomplish the assigned task(s).

PUBLICATIONS AND EQUIPMENT:

(a) Photo computer

(b) Utilization Manual (TARPS)

(c) Unit camera resolution records

(d) Sensor availability data

(e) Aircraft availability data

(f) Film processing curves

(g) Mission planning forms

Time 00:03:

1. EEIs (determined with the assistance of the AIOs):

Spot Size _____ Scale _____

Area coverage _____

Other _____

Time 03:10:

1. Sensor capabilities: Given spot size and coverage requirements and using average resolution data, determine the capability of each sensor to fulfill the tasking. (Actual resolution values for the particular sensor as determined from resolution logs shall be used for final crew planning).

   a. Forward oblique (KA-87)

      ALT _____ CVG _____ SS

   b. Vertical cameras

      _____ ALT _____ CVG _____ SS

   c. Panoramic cameras

      _____ ALT 3411 _____ ALT _____ SS

      Check V/H limits

   d. _____ ALT _____ CVG _____ SS

Time 10-15:

1. Determine the best sensor based on:

   a. Order of battle (affects altitude)

   b. Target approach (may affect coverage requirement)

   c. Weather (ceiling) _____

   d. Best sensor _____

      Justification _____

   e. Back-up sensors:

      Primary aircraft _____

      Secondary aircraft _____

2. Consider various film types:

   a. Black and white (resolution vs. speed)

   b. Color (reduced resolution; good target detection)

   c. CDIR (reduced resolution; good target detection and water penetration capability)

   d. Black and white IR (best haze penetration)

Time 15-20:

1. Board discussion of alternatives and final decision of the chairman.

Time 20-58:

1. Sensor considerations:

   a. Primary Aircraft

      Sensor OPT ALT/SS/CVG *MAX ALT/SS/CVG *MIN ALT/SS/CVG

      _____

   b. Secondary aircraft

      Sensor OPT ALT/SS/CVG *MAX ALT/SS/CVG *MIN ALT/SS/CVG

      _____

   c. Data for alternate sensor in primary aircraft

      Sensor OPT ALT/SS/CVG *MAX ALT/SS/CVG *MIN ALT/SS/CVG

      _____

2. Determine sensor launch/abort criteria:

a. Primary aircraft

Launch _____

Minimum for run _____

3. Review sensor limitations and operation:

a. Film load vs. coverage

b. V/H limits

c. ON/OFF points

d. Review charts

4. Compute apparent scene brightness (foot lamberts).

5. Compute S/C and gamma and enter in mission planning form.

6. Complete mission planning form for each aircraft.

7. Report progress to Chairman for possible reassignment of duties.

TIME 58-60:

1. Provide chairman with required information.

3._____ Plot orders of battle and provide information on threat systems.

( ) EOB ( ) SAMOB ( ) SOB ( ) AAA ( ) NOB

4._____ Obtain prior intelligence on the target and area of interest.

5._____ Research the rules of engagement.

6._____ End products required/date:

B & W NEG _____ DUPE NEG _____

HOT PRINTS _____ COLOR POS _____

SELECT PRINTS _____ COLOR PRINTS _____

DUPE POS _____ CDIR _____

OPREP-1 _____ SPOT REPORT _____

OPREP-2 _____ IPIR _____

OPREP-4 _____ OTHERS _____

TIME 10-15:

1. Electronic Evaluator: Order of battle threats.

Primary _____

Secondary _____

Tertiary _____

2. Air Intelligence Officer: _____

Target Name _____

Location _____

Description _____

_____

Launch time _____ TOT _____ Recovery _____

Topography _____

Weather _____

SERE/SAR Information _____

Divert fields _____

_____

Enclosure (4 Cont)

TIME 15:20:

1. Board discussion of alternatives and final decision by the Chairman.

TIME 20:58:

1. Plot route (including coordinates of all checkpoints and targets).
2. Include on charts:
   (a) Attitudes/headings
   (b) Speeds/distances
   (c) Profile (climb, descent)
   (d) Camera ON and OFF points
   (e) Inflight refueling points (if required)
3. Obtain SAR/SERE information (not to be annotated on actual mission charts).
4. Individual checklists:

PILOT

a. Fuel log _____

b. Tanking procedures _____

c. Escort rendezvous _____

d. Weather minimums _____

e. Abort criteria _____

f. GO/NO-GO criteria _____

g. Rules of engagement _____

h. Escort brief _____

RIO

a. Camera firing rates _____

b. Camera V/H settings _____

c. Exposures per target _____

d. Total exposures _____

e. Alternative target _____

f. Communications _____

g. Control agencies _____

5. Report progress to Chairman for possible reassignment of duties.

f. Target Heading/Speed. Discuss reasons for selecting each target heading/speed such as order of battle, terrain, and so forth.

g. Course of action in case of unexpected weather.

h. Return flight and recovery (fuel remaining).

V. RIO's Presentation

1. What reconnaissance configuration was chosen for the primary and backup aircraft(if used)?

   a. Forward Oblique _____

   b. Vertical Camera _____

   c. Panoramic Camera _____

   d. Infrared _____

   e. Other (film, etc.) _____

2. What were the major considerations in selecting configurations? Film load versus coverage required/WX/ altitude/profile/sensor reliability/spot size requirement, and so forth.

3. What spot size would you consider maximum allowable to fulfill the required EEIs?

4. What spot size do you expect to achieve with your imagery?

5. What is your programmed altitude (minimum, maximum and optimum)?

6. Give brief rundown on sensor utilization in target area, including when cameras are ON and OFF. coverage, film usage and so forth.

7. Divert fields and processing capabilities.

VI. Closing Remarks (CHAIRMAN)

Open the floor for questions.

# MISSION PLANNING FORM

PHOTO LAB JOB CONTROL INFO

| CLASSIFICATION 01 | PROJECT NUMBER 02 — 05 | UNIT 07 — NUMBER 09 — MEDIA 14 | O R 16 |
|---|---|---|---|
| REQUESTER SUPPLIED INFORMATION ORGANIZATION | NAME OF REQUESTER | UIC 17 | CUSTOMER JOB NUMBER 22 |
| PHONE | AUTOVON PREFIX | RECEIVED DATE 45 — 47 — 50 | |
| PILOT | RIO | EVENT | ETO / A C / POO / FLT TIME |
| DATE (DAY MONTH YEAR) | MISSION | SQUADRON | OET / SORTIE |

MISSION DATA

| SENSOR DATA | FRAME CAMERA | PAN CAMERA | IR SENSOR | | |
|---|---|---|---|---|---|
| FILM TYPE | | | | | |
| FILM LOAD | | | | | |
| S/C | | | | | |
| FILTER | | | | | |
| DDS EXP/PW | 1-2-3-4-5 | 10-15-20-25 | 1-2-3-4-5 | | |
| GAMMA | | | | | |

REQUIREMENTS SET BY DAY TIME

MAINTENANCE

| | | | | | |
|---|---|---|---|---|---|
| CAMERA NO. | | | | | |
| MAGAZINE NO. | | | | | |
| SUPPLY NO. | | | | | |
| TAKE UP NO. | | | | | |
| EMULSION/TYPE | | | | | |
| PRECOUNT | | | | | |
| POSTCOUNT | | | | | |

LAB DELIVERY BY DAY/TIME I O NUMBER

PROCESSING DATA

| | | | | | |
|---|---|---|---|---|---|
| PROCESSOR NO. | | | | | |
| CALIBRATED FPM | | | | | |
| TEMP | | | | | |
| DEVELOPED GAMMA | | | | | |
| QUALITY OF FILM | | | | | |
| FOOTAGE | | | | | |
| DAY/TIME | | | | | |
| PROCESSED BY | | | | | |

FILM PICKED UP BY DAY/TIME

REMARKS

and for CVIC personnel to make pre-mission preparations.

MAINTENANCE SECTION.—After receiving the mission planning form, the line maintenance personnel begin preparing the sensors, associated equipments, and aircraft for the mission. The maintenance section of the form is filled in by maintenance personnel as the various tasks are completed. After the aircraft returns from the mission, the film is removed, and the appropriate postflight counter settings are entered in the maintenance section. The film, along with the mission planning form, is then delivered to the CVIC.

PROCESSING DATA SECTION.—The exposed film, and the mission planning form with the mission data and maintenance sections completed, are forwarded to the CVIC for film processing and evaluation. The film is processed in accordance with the data entered in the mission data section of the form. The results of film processing are entered in the processing data section of the form. The film is evaluated for image quality and the appropriate entries are also made in the processing data section. The completed mission planning form is returned to the reconnaissance coordinator for purposes of debriefing and filing for future reference.

**Dynamic Resolution**

Dynamic resolution is defined as the ability of a camera system to produce a sharply defined image under the environmental conditions experienced during flight. Dynamic resolution is expressed in terms of "lines per millimeter" ($\ell$/mm) recorded by a given film type under specific conditions. The dynamic resolution of a camera system mounted in an aircraft is affected by various factors, some of which are:

Camera quality

Film characteristics

Camera mounting

Atmospheric conditions

CAMERA QUALITY.—The major factor affecting camera system dynamic resolution is the optical quality of the camera lens system. Optical quality is the ability of the camera lens system to reproduce or resolve the finest detail of a scene and is stated in lines per millimeter. For example, if a lens system is rated at 50 $\ell$/mm, it can resolve 50 separate and distinct lines in 1 millimeter.

FILM CHARACTERISTICS.—Other important factors affecting camera system resolutions are the characteristics of the film being used; for example, the structure characteristics of the film, the film speed, etc.

CAMERA MOUNTING.—Aircraft motion and vibration affect system dynamic resolution. The effects of motion and vibration on a vertically stabilized camera are negligible, as long as the limits of stabilization are not exceeded. The effects of motion and vibration on hard mounted cameras are an important consideration and can be reduced by a judicious selection of film type. Films with the greatest resolving power are also the films with the slowest speed. The resolution of these films is greatly reduced by the effects of motion and vibration since longer exposure times are required. The faster films have lower resolving power but are not seriously affected by motion and vibration because of the shorter exposure times required. In many cases, a satisfactory trade-off between exposure time and resolving power can be made.

S/C (FILM SENSITIVITY/FILTER FACTOR) CONTROL SETTINGS/FILM SPEED SETTINGS AND FILM PROCESSING PARAMETERS.—The dynamic resolution of a camera system depends on many factors, one of which is negative contrast. The contrast of a negative can be altered through the use of filters over the lens of the camera and/or by varying film processing parameters. Filters can be used to enhance the contrast of a negative, increasing the

resulting resolution. When filters are used, a change in exposure will result which can be corrected by making the proper setting of the S/C control on panoramic (pan) cameras or the film speed control on frame cameras. The setting of these controls is primarily a function of film speed and filter factor. Other considerations such as atmospheric conditions and weather conditions may also figure in the proper setting of the controls. Negative contrast can be altered by varying film processing parameters such as machine speed, processing solution, temperature, and/or type of developer.

ATMOSPHERIC CONDITIONS.—Another factor affecting the dynamic resolution of a camera system is atmospheric conditions. Atmospheric visibility can vary causing the apparent contrast of the target to its surroundings to vary. As the contrast of the target to its surroundings decreases, the ability of the camera system to resolve the target is decreased. This effect can be greatly reduced by the proper use of filters, the use of high gamma film processing, and the selection of the best film type for the task. For high altitude or long slant range photography, a high resolution film/high gamma processing combination should be used, in conjunction with the proper filter, to reduce the effects of contrast reduction caused by poor atmospheric visibility.

**Sensor Considerations**

A major task during reconnaissance mission planning is to ensure that the required target intelligence information can be acquired by selecting the proper sensor.

In selecting the sensor for a recon mission, many factors must be taken into account. Although standoff photography of an enemy target is generally preferable, for safety reasons, to overflight, the necessary image quality and visibility conditions may make it necessary to overfly the target or closely approach it with increased risk of detection or aggressive counteraction. For most target requirements at low or intermediate altitudes, a panoramic (pan) camera will provide satisfactory coverage.

Altitude ranges are defined as follows:

Low altitude—0 to 1500 feet

Medium altitude—1500 to 10,000 feet

High altitude—10,000 feet and above

For flight path plots, prestrike route segments, targets, and checkpoint photography, a forward oblique serial frame camera provides satisfactory photography over a wide range of aircraft speeds and altitudes or velocity/height (V/H).

In a vertical position, a frame camera provides backup photography for bomb damage assessment (BDA), route area, ship photography, mapping, and some aspects of air-to-air photography.

For low to medium altitude reconnaissance, limited standoff, or coastal coverage, a pan camera provides satisfactory photography.

MULTISENSOR.—Multisensor reconnaissance entails the use of two or more similar sensors; for example, two or more photographic cameras with varied focal lengths and depression angles, the use of sensors with different spectral capabilities (photographic cameras using color film and infrared detecting system), and/or coverage of the same target area with two or more sensors during the same mission. Some advantages of multisensor reconnaissance are:

- The unique imaging capabilities of different sensors can be used to complement each other. For example, an infrared reconnaissance set (IRRS) or a frame and/or pan camera using camouflaged detection infrared (CDIR) film can detect a camouflaged truck that may not record using cameras containing black and white film.

- Cameras using color film can augment the capabilities of cameras using black and white film. Each offers advantages the other can't. Black and white film records approximately 30 discernible gray tones while color film can record about 267 distinct hues.

- When a camera with a wide angle of view is used in conjunction with another camera with a narrow angle of view, the probability of covering the target with one or the other, or both, is increased.

- The imagery from one sensor can act as a reference of source or orientation of imagery from another sensor.

- A greater range of aircraft speed and altitude operation may be provided when one sensor is better adapted to low altitude high speed operation and the other extends coverage to higher altitudes.

- The images from one sensor may be used to enhance data extracted from imagery of another sensor. An example is the use of an IRRS and a photographic frame or pan camera during low-light level conditions.

**Weather and Associated Factors**

Weather and associated factors also have a bearing on mission planning, sensor selection, sensor use, and the quality of images obtained.

Some of these factors are:

Change in temperature

Visibility restrictions

Compressibility (the bending of light rays as they pass through a shock wave caused by supersonic flight)

Color of light

Shadows

Availability of light

The amount of light absorbed by the atmosphere

TEMPERATURE INVERSIONS.—Temperature inversions in the atmosphere tend to concentrate and trap particles in the air, thus causing haze. A common temperature inversion may be characterized by smoke which rises to a certain height, then flattens out and goes no higher. This condition makes it difficult to photograph the ground. The inversion effect, or haze, can be countered by using a red filter and a film sensitive to red light or to infrared radiation. However, neither of these will, so to speak, cut through smoke.

THERMAL SHIMMER.—Thermal shimmer is the result of heated air moving upward. When thermal shimmer is occurring, distant objects appear to shimmer because of light rays being refracted by the rising heated air. This phenomenon can obscure minute detail in high altitude photography. When thermal shimmer exists, sufficient photographs of the target should be made to ensure that all details will appear in at least one photograph.

COMPRESSIBILITY.—Light rays are bent as they pass through a shock wave caused by supersonic speed. This effect occurs only during supersonic flight and causes minor image distortion in the area of the shock wave zone. This is often seen in the images made with a vertical frame or pan camera when the aircraft speed is near Mach 1.

COLOR SHIFT.—The predominately red color of sunlight in early morning and late afternoon changes the photographic appearance of ground objects. When using black and white film, the lack of blue and green light will cause ground objects to record in different shades of gray than if shot during the middle of the day. The predominately red light causes an overall reddish cast to images made on color film.

SHADOWS.—When reconnaissance photography of targets which are predominately in shadow is to be made, the basic exposure should be increased by about two to four times. Oblique photographs should be made across the shadow line and not into the sun to reduce the glare of atmospheric light scattering and to

preclude internal reflections in the lens and camera.

> The use of filters can improve haze penetration and is recommended when sufficient light exists. Improvement in contrast by the use of filters is made at the expense of exposure time. When filters are used, it may be necessary to change flight altitude, aircraft speed, or the offset ground track distance, or any combination of these, in order to satisfy the reconnaissance requirements.

AVAILABLE DAYLIGHT.—Camera systems in aircraft produce the best photography when the sun is about 20 degrees or higher above the horizon. Aerial recon photography made at sun angles below about 20 degrees is possible but requires careful selection of film and filters. The number of hours of useful daylight is dependent on the time of year and the latitude. The period of low sun angle can provide useful intelligence and may be used to take advantage of certain targets. Since an infrared reconnaissance set does not need light to get an image of the target, this period of low sun angle is a good time to use an IRRS.

SURFACE TEMPERATURE.—Surface temperatures can and do affect image-forming sensors, particularly infrared sensors. The heating of the earth's surface is called insolation. Insolation, which is the rate of delivery of all direct solar energy per unit of horizontal surface, is proportional to the directness of the sun's rays through the daily solar cycle, increasing until about noon and then decreasing through sunset. As objects on the earth's surface absorb this energy, their emission of radiation heat energy is increased.

Because of the warmup time, the radiation from the earth peaks about midafternoon and continues at a high rate for several hours after sunset. Different surfaces of the earth (objects/targets) absorb and radiate this energy at different rates. Thus, even when the available light is insufficient for regular picture photography, infrared (IR) photography is possible using an IRRS.

## MISSION CALCULATIONS

Mission calculations provide the methods which enable flight crews and mission planners to determine aircraft specifications, and sensor specifications such as scale, resolution, ground coverages, film usage rates, and other specifications for a given set of conditions.

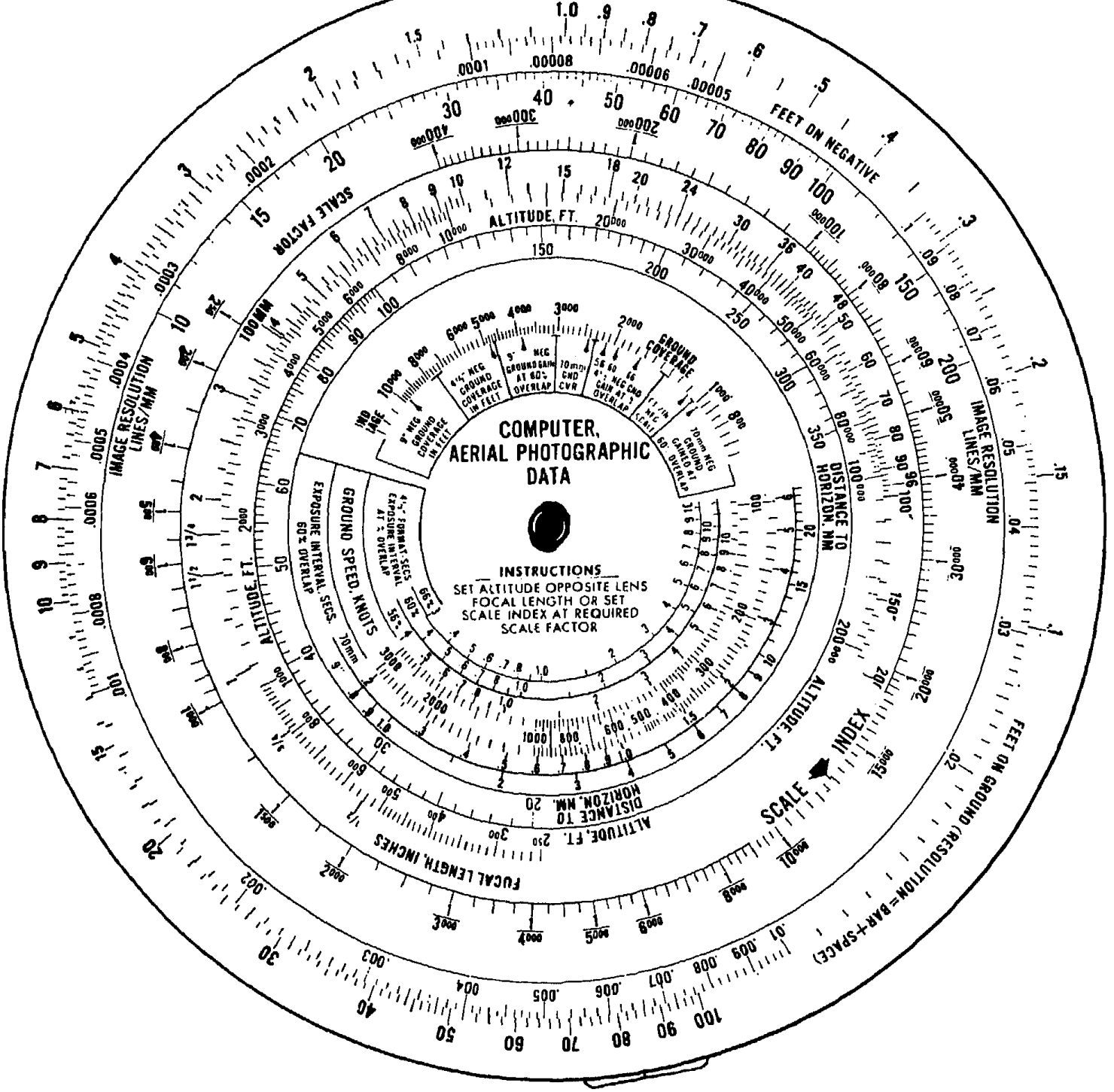
The use of an aerial photographic coverage and flight planning computer such as the Aerial Photographic Data Computer, Type BM-38A, can facilitate many of the mission calculations required for mission planning.

### Aerial Photographic Data Computer

An aerial photographic data computer contains scales, indexes, and information pertaining to frame and panoramic camera photography as well as radar and infrared detection mapping. A computer can be a useful tool in recon mission planning. It can give quick answers to various mission requirements with a minimum of data relative to the impending mission.

The basic requirement for using an aerial computer is a knowledge of the characteristics of the image-forming sensors available for the mission. To solve most mission planning image-forming sensor problems with an aerial computer, one or more of the following mission requirements must be known:

- Scale factor.
- Minimum safe aircraft-to-target distance as may be dictated by terrain or defenses at or near the target.
- Minimum spot size or object resolution required depending on whether the mission objective is detection, identification, description, or analysis of the target. These requirements must be known or assumed to be of specific value until circumstances indicate otherwise.

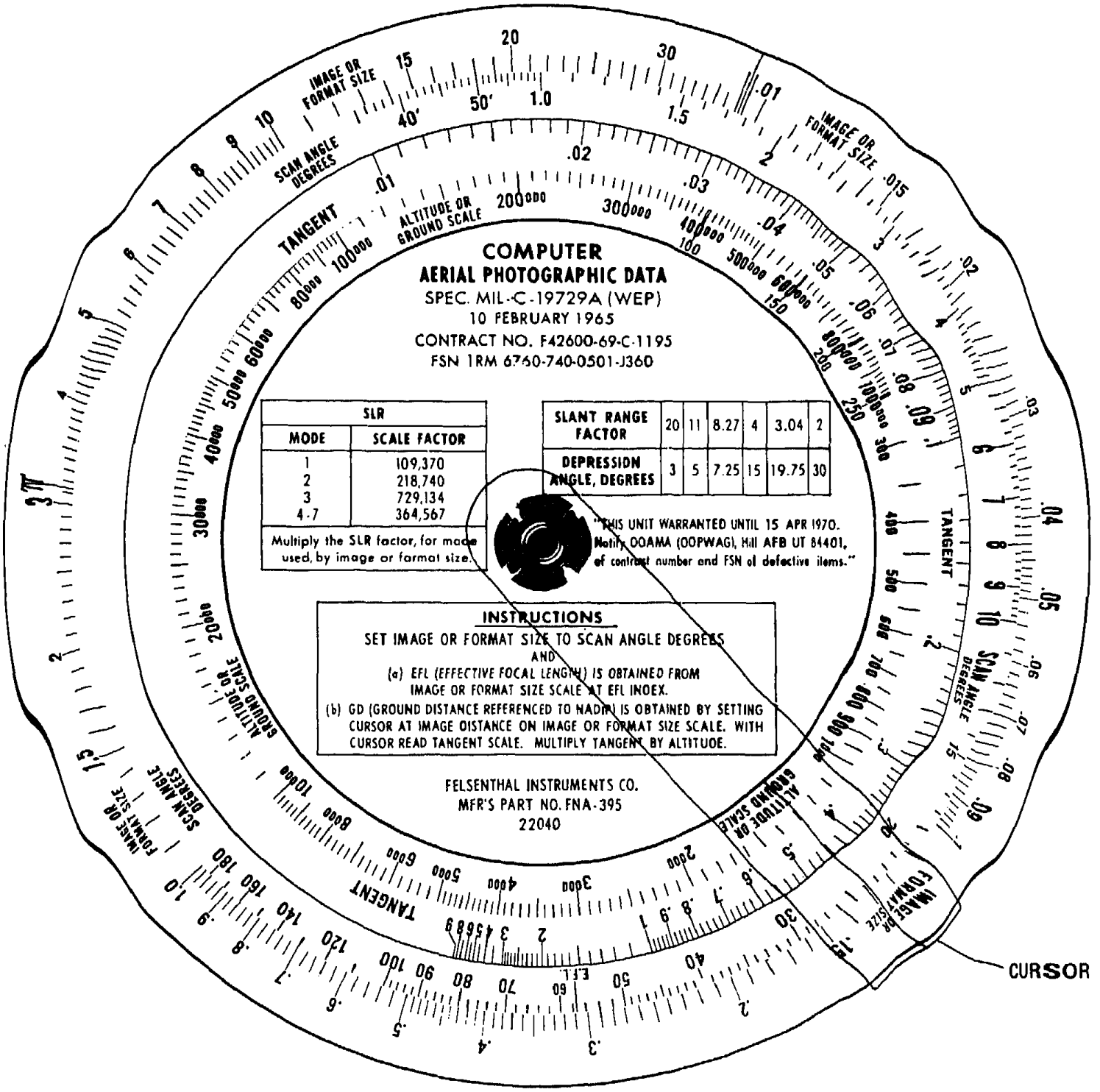



**Aerial photographic data computer scales (Front).**

The primary objective for using an aerial computer for mission planning is to select an image-forming sensor that will satisfy the mission requirements. When a sensor is arbitrarily selected, the computer can be used to verify that all image-forming sensor requirements can be met using that sensor.

The method used to select an image-forming sensor is:

1. List the mission requirements.
2. Become familiar with image-forming sensor data, such as capabilities, limitations, and characteristics.




**Aerial photographic data computer scales (Back).**

3. Use the mission requirements and sensor data with a computer to select or reject various sensors.

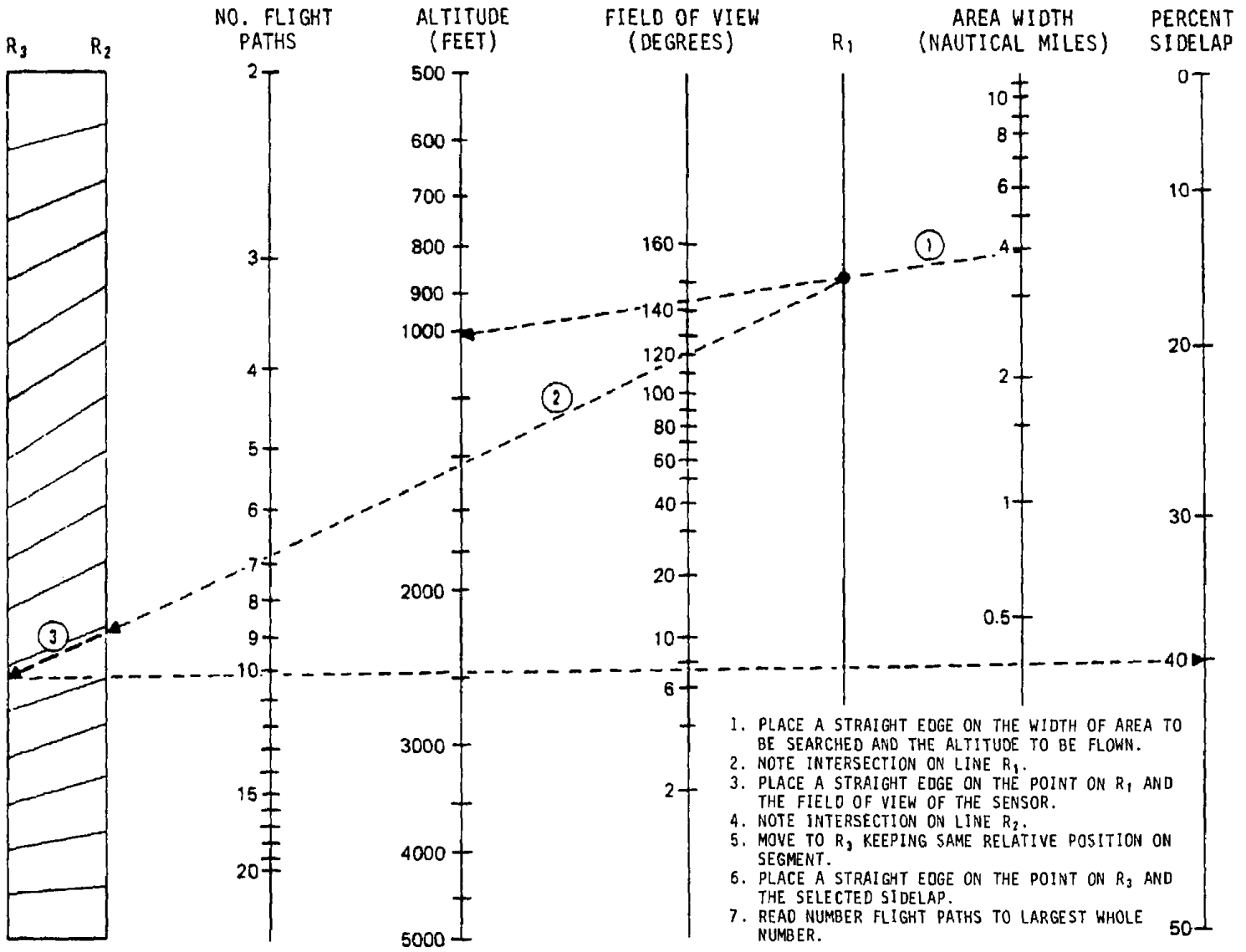
The secondary objective of the computer is to determine other mission planning data, such as ground coverage, ground gained, ground coverage per inch of negative, and exposure intervals. This data can readily be obtained using a computer, once a specific sensor has been selected.

When you are using the BM-38A computer, which is the one currently available to PHs, refer to the Photographic Computer Instruction Book RC-025063 for detailed instructions for its use.

## Flight Line Requirements

Prior to a recon or mapping flight where it will take more than one flight line to obtain the required coverage of the target area, the required number of flight lines must be determined. The flight lines should then be drawn on the flight chart in an easily recognized color. The first flight line is flown along the border of the area to be photographed. The rest of the flight lines are evenly spaced, parallel to one another, on the flight chart.

A nomograph is shown in the next figure for determining the number of flight lines required to cover a target area. This nomograph is for low altitude coverage only.



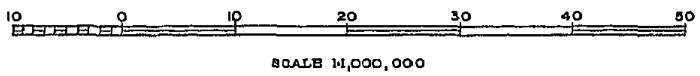

**Number of flight lines nomograph.**

## MAPPING PHOTOGRAPHY

A vertical photograph is a detailed map of the area shown. The area covered by the photograph may be quite limited, especially if the photograph was taken from a low altitude. By working from a higher altitude a larger area is included, but each part of the area is shown in a smaller size. To increase the area covered at a low altitude, a series of overlapping photographs are made, then spliced together to form one large photograph. In this way a large area is covered and the objects on the ground are reproduced in a relatively large size.

Usually, the area to be mapped is indicated on a chart, and its maximum boundaries are given. The scale fraction of this chart, or its linear scale, is important information. The amount of area to be covered is found from one of these scales.

The scale of a map is usually quoted as a common fraction and read as a ratio. For example, the scale may be given as 1/10,000 on the map, but is read "one to ten thousand," as if it were written 1:10,000. It may also be written as a ratio. In either case, it means that one unit of measure on the map is equal to 10,000 such units on the ground.




A standard legend scale.

The first problem encountered in aerial mapping is finding the scale of the mosaic map. If the scale that is required is given, then the altitude and focal length have to be found to get that required scale.

The scale of a photographic mosaic map is calculated as follows:

S = Scale of the map

F = Focal length of the lens

A = Altitude above the ground

As F is in inches, A (altitude measured in feet) is multiplied by 12 to convert to the same unit of measurement (inches). Then:

$$S = \frac{F}{12A}$$

EXAMPLE: What is the scale of a map taken from 15,000 feet altitude, using a 12-inch lens?

$$S = \frac{12}{12 \times 15{,}000} = \frac{12}{180{,}000} = \frac{1}{15{,}000}$$

Therefore, the scale is 1/15,000. That means 1 inch on the picture equals 15,000 inches on the ground.

of the required scale of the photography and the area to be photographed. Using this information, the mission planners make several calculations to determine such things as altitude, number of pictures per flight line, number of flight lines, film requirements, etc.

There are two methods by which planners can arrive at conclusions with regard to the various mapping factors or problems. These are by common mathematical equations and through the use of an aerial photographic data computer.

The factors or problems of a photographic mapping mission which must be solved are:

Scale

Altitude

Focal length

Ground coverage in feet

Ground gained forward

Exposure interval or picture frequency

Ground speed

Shutter speed

Altitude above terrain

A "typical" mapping assignment is used to describe the operations in computing the various factors involved in a mapping mission. Working under any method, time must be taken to recheck your work for correctness. Certain parts of each problem are dependent upon other parts of the problem; as a consequence, any error made early in the calculations causes errors in the steps that follow.

The following are the conditions of the mapping problem:

The area to be mapped is 10 nautical miles east and west by 20 nautical miles north and south.

Forward overlap is 60 percent and sidelap is 40 percent.

Required scale is 1/12,000 (1:12,000).

The camera used has a 12-inch lens and produces a 9 $\times$ 9-inch negative.

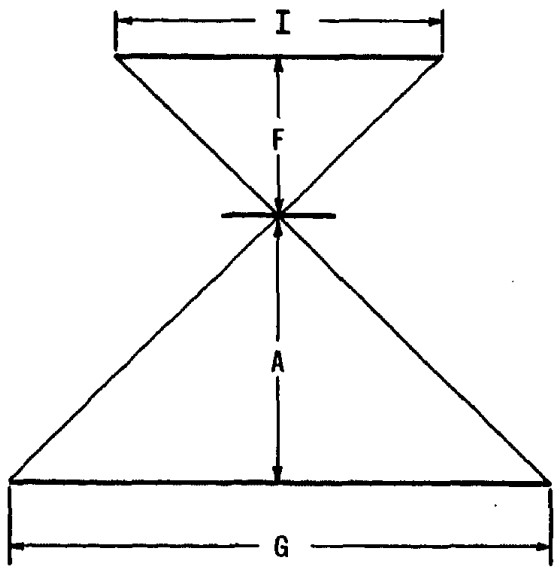
True airspeed of the mapping aircraft is 140 knots.

A graphic scale representing 3000 feet is to be constructed for the finishing mosaic.

**The completed mosaic is to have a 2-inch border.**

**The scale of the chart from which the mission is to be flown is 1/50,000 (1:50,000).**

**Since light rays from the outer limits of the photographed area pass through the geometric center of the lens to define the corresponding outer limits on the negative, similar triangles are formed. As the focal length (F) and altitude (A) are corresponding parts of similar triangles (both being altitudes of similar triangles), their ratios are also existing between the negative and the ground distances.**




I--Indicates the length or width of the base of the triangle in the camera in inches (the plate size or any designated portion of it).
F--Indicates the distance from the center of I to the optical center of the lens in inches.
G--Indicates the length or width of the base of the triangle outside the camera in feet (ground covered by each exposure or any designated portion of it).
A--Indicates the distance from the center of G to the optical center of the lens in feet.

**In the above figure, the relationship of I to F and G to A forms a proportion and may be expressed as:**

$$\frac{I}{F} = \frac{G}{A}$$

**It is a simple matter to change the fractional expression of an equation to a linear or simple equation by multiplying the numerators by the denominators; remembering that what is done to one side of the equation must be done to the other. In the above proportion, multiply I and G by F and A, thus deriving the equation:**

$$\frac{IFA}{F} = \frac{FAG}{A}$$

**Cancel factors appearing both as numerators and denominators in each fraction:**

$$\frac{I\cancel{F}A}{\cancel{F}} = \frac{F\cancel{A}G}{\cancel{A}}$$

Through cancellation, the above equation becomes the linear equation $IA = FG$. To clear for I in this equation, divide both sides of the equation by A, or

$$\frac{IA}{A} = \frac{FG}{A} \quad \text{or} \quad I = \frac{FG}{A}$$

At what altitude must the mission be flown to obtain the desired scale of 1/12,000? The linear equation $IA = FG$ is used here to determine the scale. Divide both sides of the equation by I to clear for A, or

$$\frac{IA}{I} = \frac{FG}{I} \quad \text{or} \quad A = \frac{FG}{I} \quad \text{or} \quad A = \frac{12 \times G}{I}$$

Since G, or the length or width of the base of the triangle outside the camera, is not known, a known factor must be substituted for it. (G indicates the length or width of the base of the triangle outside the camera, or any designated portion of it; I indicates the length or width of the base of the triangle in the camera, or any designated portion of it.) At a required scale of 1/12,000, each unit of I will record 12,000 units of G. Thus, these factors may be used in the equation to solve for A. Since A is measured in feet, the answer must be divided by 12, or, more simply, multiply I by 12 in the equation.

$$A = \frac{FG}{I} \quad \text{or} \quad \frac{\overset{2}{\cancel{12}} \times 12{,}000}{1 \times \underset{1}{\cancel{12}}} = 12{,}000 \text{ feet}$$

Therefore, the altitude to be flown is 12,000 feet.

In order to find the focal length of the lens required to obtain a desired scale of photography from a specified altitude, the linear equation is again used. F is determined by dividing both sides by G, or

$$\frac{IA}{G} = \frac{FG}{G} \quad \text{or} \quad F = \frac{IA}{G}$$

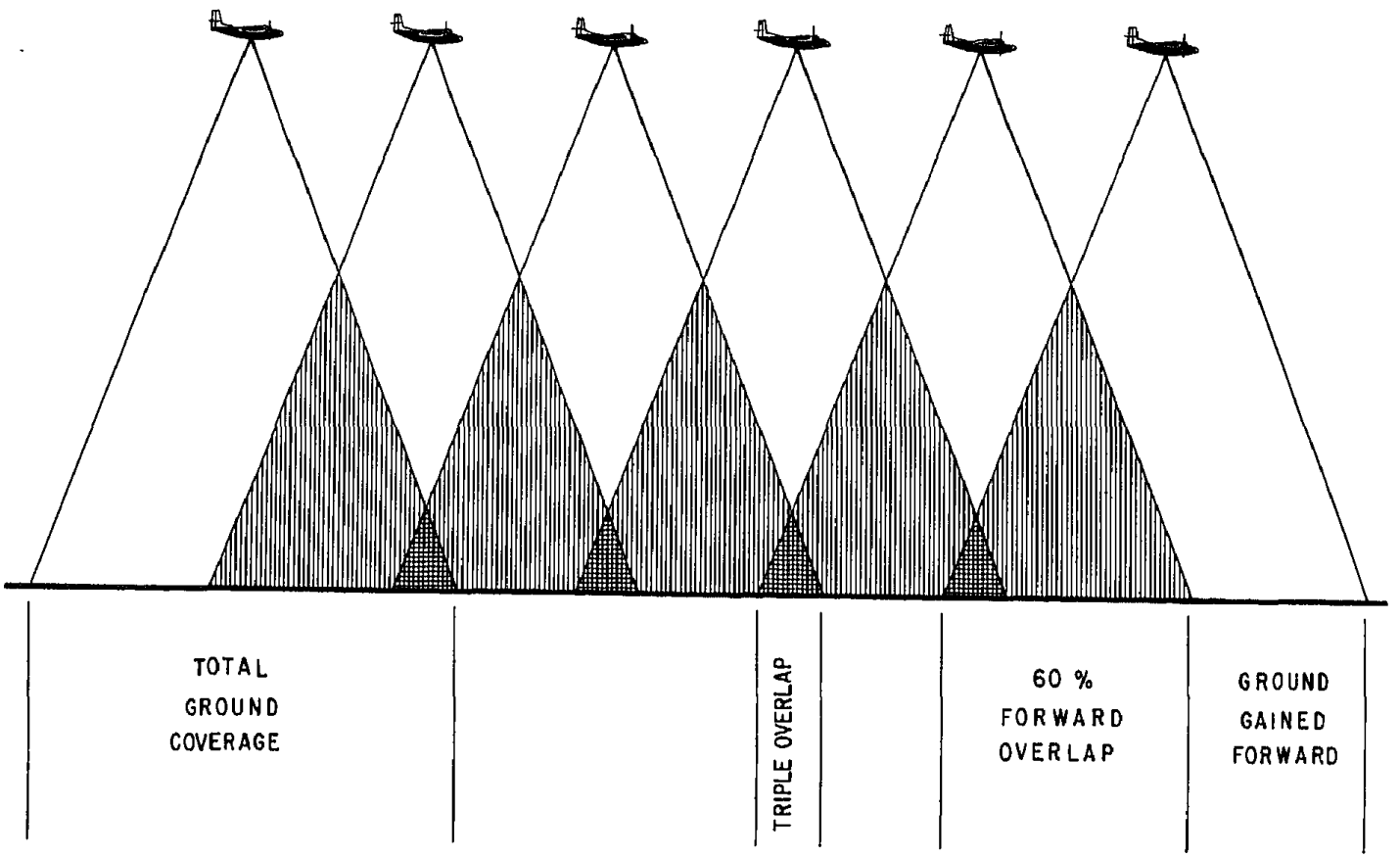
In this particular case, I and G are unknown. The scale of 1/12,000 may be used in lieu of I and G, or

$$F = \frac{1 \times 12{,}000}{12{,}000} \quad \text{or} \quad F = 1$$

Since F is required to be given in inches, multiply the answer by 12 to get inches (in this case 12 inches).

**Having obtained the altitude at which the mission is to be flown, next calculate the amount of ground coverage shown in each picture. To accomplish this, divide the linear equation by F, or**

$$\frac{IA}{F} = \frac{FG}{F} \quad \text{or} \quad G = \frac{IA}{F}$$




**Forward overlap.**

**Substituting the units of measurements in the like units of the above figure, it becomes a simple problem of multiplication and division. The camera in this problem has a 9 × 9-inch format, a 12-inch focal length, and the aircraft is to fly at 12,000 feet. Thus,**

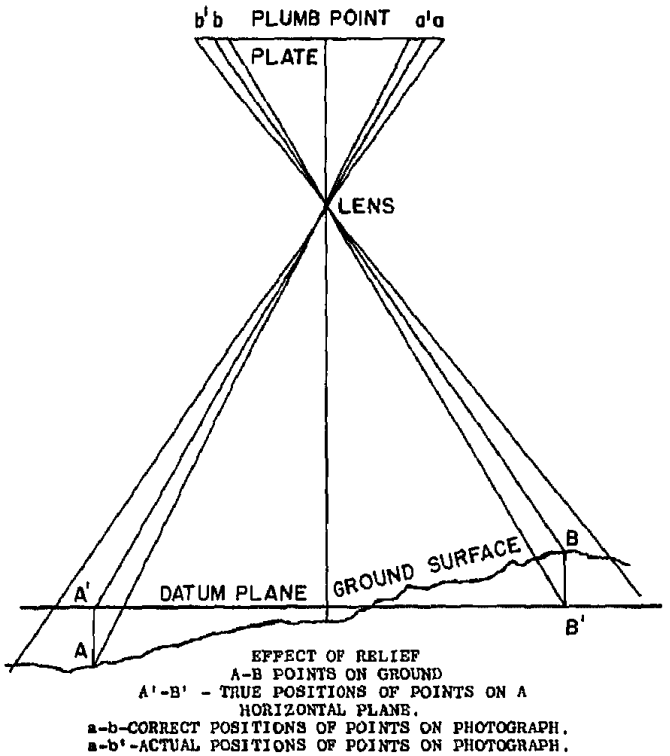
$$G = \frac{IA}{F} \quad \text{or} \quad G = 9 \times \frac{\overset{1000}{\cancel{12{,}000}}}{\underset{1}{\cancel{12}}} \quad \text{or} \quad G = 9000 \text{ feet}$$

Since the negative format is 9 × 9 inches, it also covers the same amount from side to side as it does from end to end.

## Overlap

In order to ensure complete coverage of the area being photographed, each photograph in each flight line or strip must overlap the preceding and following photographs. The amount of overlap on each photograph is 60 percent. In other words, each photograph is taken so that it normally overlaps both the previous and following photographs in the strip. Creating this overlap ensures that there are no blank areas in the strip, and subsequently in the mosaic map.

The overlap also serves another important function. In the construction of a mosaic map, only the central portions of each print are used. This practice is followed because the middle areas of all vertical photographs are the areas of truest reproduction of terrain as illustrated in the next figure.




Effect on scale when photographing over rough terrain.

In the above figure, the aircraft is assumed to be flying over a mountain while making a series of verticals with the camera in a vertical position. When the aircraft is directly over the mountain, a perfect reproduction of the mountain form is obtained (insofar as mapping is concerned). Pictures made prior to and subsequent to the one made directly over the mountain show clearly the near side of the mountain, but very little if any of the far side. This is caused by the different camera positions with respect to the subject matter.

Scale is affected by this differential of camera positions. It is practically impossible to match the edges of prints when these distortions of the terrain are present. Therefore, the outer areas (toward the edges of the prints) are discarded in favor of the inner 40 percent (middle) of the prints. The art of stereoscopic measurement associated with either contour mapping or photographic interpretation requires the highest degree of accuracy. This is another reason for using only the middle 40 percent of each print for plotting contours and laying mosaics.

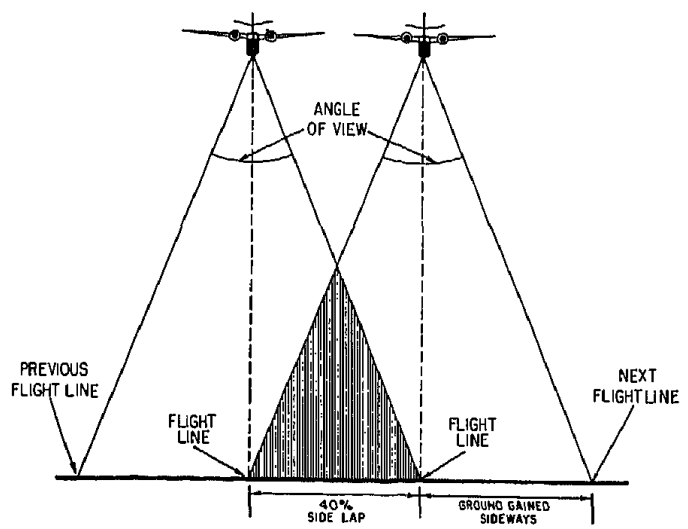
Since a 60-percent overlap is created, there remains only 40 percent of usable ground gained forward in each negative; or 3.6 inches of a 9 × 9-inch format size. To find the actual amount of usable ground gained forward in each negative, multiply the ground coverage (9000 feet in the problem) by 0.40. The product—3600 feet—is the usable ground gained forward (GGF).

The formula, IA = FG, may also be applied if the total ground covered on each exposure needs to be determined. Again, by dividing IA = FG by F, the formula G = IA/F is derived. In solving for the usable ground gained forward, the 3.6 inches of format size made good on each exposure is used in place of the 9-inch format. Thus,

$$G = \frac{3.6 \times \overset{1000}{\cancel{1}\cancel{2},\cancel{0}\cancel{0}\cancel{0}}}{\underset{1}{\cancel{1}\cancel{2}}} \quad \text{or} \quad G = 3600 \text{ feet}$$

## Sidelap

When you are photographing for a mosaic map, normally more than one flight strip has to be made as the area to be photographed is usually wider than can be photographed in one strip. To get complete coverage, the aircraft has to fly successive side-by-side strips so that none of the area is missed. Since only the central portion of each photograph is used in laying the mosaic map, each successive strip must overlap the preceding strip—usually by 40 percent.



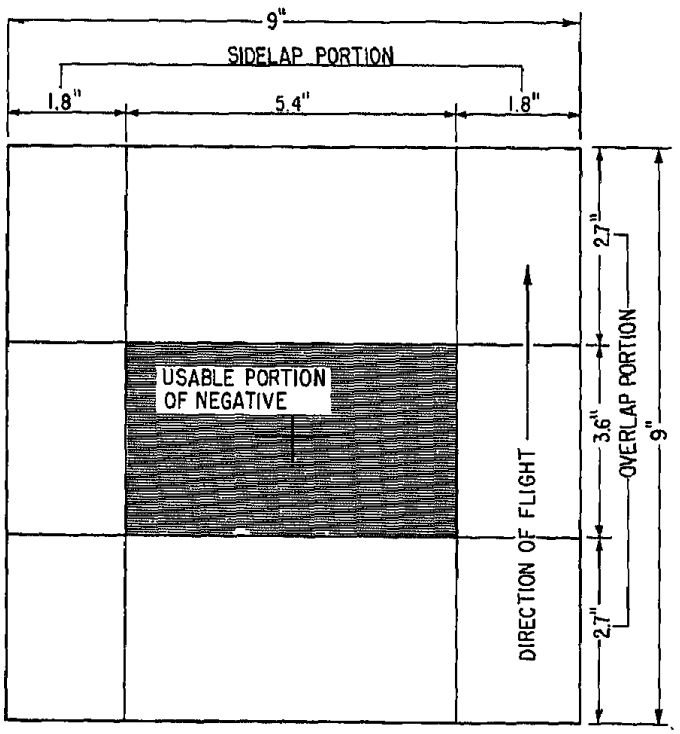

Sidelap.

gain, but substituting 5.4 instead of 3.6, the results are:

$$G = \frac{\frac{1000}{5.4 \times 12{,}000}}{\frac{12}{1}} \quad \text{or}$$

G = 5400 feet usable ground gained sideways (GGS)

As there are different amounts of overlap and sidelap used in this problem, an overall rectangular picture is actually produced.




Usable portion of a 9 × 9 inch negative.

In this situation, the shorter dimension of the picture is always used for the ground gained forward so that as few flight lines as possible have to be flown to eliminate all possible error in lining up on the successive flight lines. The longer dimension is always used for the ground gained sideways.

## Number of Exposures

In flying for a mosaic map, the flight strips are generally made along the long dimension of the area to be photographed. The problem sets up the area

to be photographed as 10 nautical miles east and west by 20 nautical miles north and south; therefore, the strips are flown north and south.

The number of exposures per strip is found by dividing the ground gained forward into the length of the map. The unit of measure is the nautical mile which has to be converted to feet for purposes of this problem. This is done by multiplying 6080 feet (number of feet in a nautical mile) by 20 (north/south length of map), or:

$$6080 \times 20 = 121{,}600 \text{ feet}$$

Divide this product by 3600 and get the quotient 33.77, or 34 pictures per strip.

In addition to the 34 pictures of the strip, it is necessary to take 4 more—2 at each end of the flight strip—making a total of 38 pictures for each strip.

At the instant of camera operation (under the prevailing flight conditions), the two extra photographs taken before reaching the beginning point are placed as correctly as possible. However, the calculated beginning point must be placed correctly in the third photograph of the series. Two additional photographs are made (in the normal timing sequence) at the end of the flight strip before stopping camera operation for that run. These four extra photographs cover a possible error in reading the beginning point and the end point of the run on the ground from the data shown on the flight chart.

In computing the total number of flight strips to be flown to cover the area, the same method is used. The total width of the area is divided by the ground gained sideways to find the total number of strips. The computation of the number of flight strips is:

10 (nautical miles) $\times$ 6080 (feet) = 60,800 feet, and 60,800 divided by 5400 = 11.25 or 12 flight strips.

One extra flight strip is added for a total of 13 strips. This extra strip is the same type of "insurance" as the extra photographs at the ends of each strip.

To find the total number of photographs required for the entire mosaic map, multiply the number of photographs required for each strip by the number of strips, or:

$$13 \times 38 = 494 \text{ photographs}$$

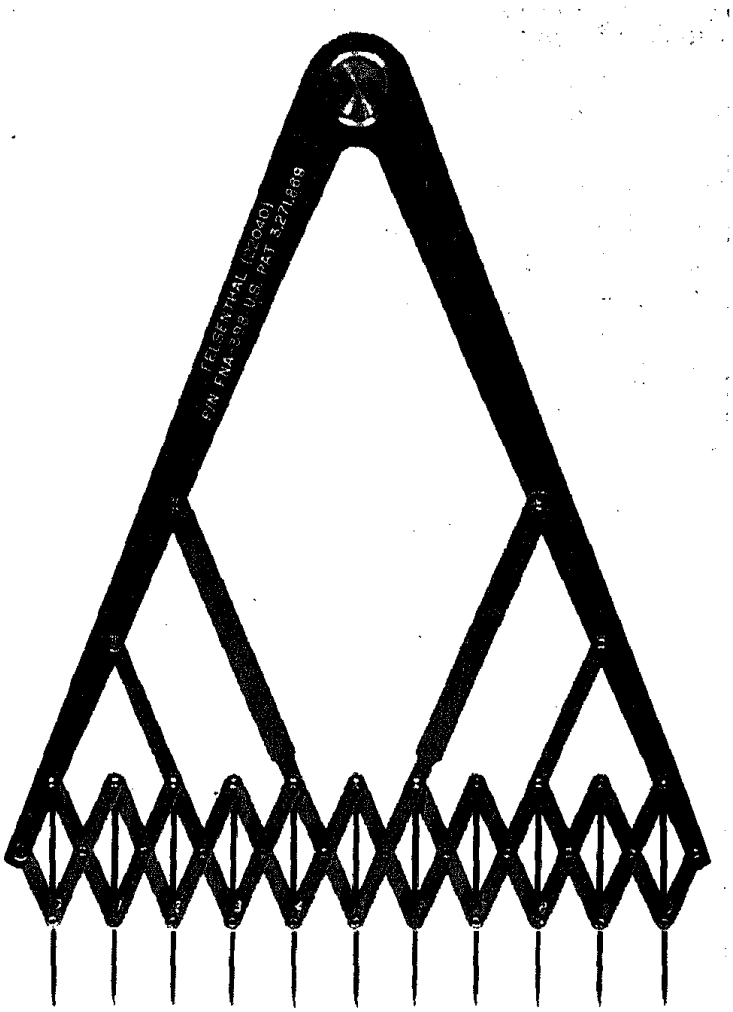
If the camera holds enough film for the entire mission, there is no problem. If, however, the camera doesn't hold enough film for the entire mission, the map may have to be flown in two or more sorties, or several aircraft may have to make the flight, or if the film cassette can be changed in flight, the same aircraft can finish the mission.

## Flight Lines

Prior to the mapping flight, the planning board should plot the flight lines for each run and draw them on the flight chart.

To determine the distance between the plotted lines on the chart, change the ground gained sideways into inches and multiply by the scale fraction of the chart used. In the problem, the ground gained sideways is 5400 feet, or 64,800 inches. The scale of the chart is 1/50,000. The distance between flight

lines to be drawn on the chart is 64,800 × 1/50,000, or 1.29 inches. It is rather difficult to measure 1.29 inches when plotting the flight lines. However, use may be made of an instrument known as a multifinger divider.



To use this instrument, first multiply the distance between flight lines (in this example 1.29 inches) by the number of fingers on the divider. This will give you the total flight lines plot width. Using a ruler, place the first divider finger on the 0 mark of the ruler and the last finger on the ruler mark corresponding with the total flight lines plot width. By using this procedure, the individual fingers of the divider automatically space themselves exactly the right distance apart for each flight line. The multifinger divider, set as indicated, may then be used to lay off the flight line plots.

## Interval Between Exposures

To determine the exposure interval or picture frequency, it is first necessary to convert the ground speed of the aircraft to feet per second. The problem states that the aircraft operates at 140 knots airspeed and that there is a wind of 15 knots from the north. Therefore, with the aircraft headed north, the

corrected airspeed is 125 knots (140 knots—15 knots). Convert 125 knots to feet per second by multiplying 125 by the conversion factor of 1.7 or:

$$125 \times 1.7 = 212.5 \text{ feet per second}$$

Use this formula $T = \frac{D}{S}$, in which

T = Time in seconds

D = Ground gained forward

S = Ground speed in feet per second

Substituting in the formula:

$$T = \frac{3600}{212.5} \quad \text{or} \quad 16.9 \text{ seconds}$$

Certain intervalometers are graduated in full second increments only. Therefore, when such intervalometers are being used, the fractional part of a second in the quotient is dropped in setting the timer. In so doing, slightly more than the required 60-percent forward overlap is provided, which is advantageous. In flying the south heading, the calculation is:

$$T = \frac{3600}{263.5} = 13.6 \quad \text{or} \quad 13 \text{ seconds}$$

## Finished Size of the Mosaic

To ensure that the necessary space is available and that a suitable mount is attainable, it must be determined just how large the completed project (mosaic) is to be. Remember, the area to be mapped is 10 × 20 nautical miles.

In the formula IA = FG, the unknown is I as it is still necessary to determine which image size (I) is equal to the 10 × 20 nautical mile area. Dividing the above equation by A to clear for I gives:

$$\frac{IA}{A} = \frac{FG}{A} \quad \text{or} \quad I = \frac{FG}{A}$$

Therefore:

$$I = \frac{\overset{1}{\cancel{12}} \times \overset{121.6}{\cancel{1210,000}}}{\underset{1}{\underset{\cancel{1000}}{\cancel{12,000}}}} \text{ or}$$

I = 121.6 inches in length

The problem requires a 2-inch border around the mosaic. Thus, it is necessary to add 4 inches to the length to give an overall length of 125.6 inches.

The width of the mosaic is determined in the same manner. Here:

$$I = \frac{1 \quad 60.8}{\cancel{12} \times \cancel{60,800}} \text{ or}$$
$$\cancel{12,000}$$
$$\cancel{1000}$$
$$1$$

I = 60.8 inches in width

Here again it is necessary to add 4 inches for the border giving an overall width of 64.8 inches.

## Graphic Scale

The problem requires a graphic scale to represent 3000 feet. Once again it is necessary to determine the size of the image to represent 3000 feet. Substituting in the formula:

$$I = \frac{FG}{A}$$

$$I = \frac{1 \quad 3}{\cancel{12} \times \cancel{3000}} \quad \text{or} \quad I = 3 \text{ inches}$$
$$\cancel{12,000}$$
$$\cancel{1000}$$
$$1$$

Therefore, 3 inches on the map represents 3000 feet on the ground.

## Scale of the Mosaic Map

The scale of a photographic mosaic map is determined by use of the formula:

$$S = \frac{F}{12A}$$

The answer derived through use of this formula gives a representative fraction (RF), and the RF is in like units. Since this is the case, it is necessary to convert the altitude to inches to correspond to the focal length of the lens which is already in inches. Substituting:

$$S = \frac{12}{12 \times 12{,}000} = \frac{12}{144{,}000} = 1/12{,}000$$

Therefore, the scale of the photographic mosaic map is 1/12,000 (1:12,000).

**Exposure Time (Shutter Speed)**

To reduce image motion to a minimum, as short an exposure time as possible should be used. The actual fastest shutter speed usable will depend on the combination of aircraft speed and altitude, scene brightness, filter, film, film processing and, in the case of panoramic cameras especially, the exposure interval.

**Filters and Filter Selection**

The earth's atmosphere contains matter or aerosols such as dust, dried sea salts, and minute water droplets. These particles are more highly concentrated in the lower regions of the atmosphere and for all practical purposes become nonexistent above about 30,000 feet. These aerosols are also more highly concentrated in heavily populated and developed areas, where targets of tactical interest are likely to be located. As light passes through the atmosphere containing these particles, light scattering occurs. The shorter wavelengths of light are scattered considerably more than the longer wavelengths of light, resulting in a blue haze. This haze reduces the apparent contrast between the target and its surroundings. A situation with a target to surroundings brightness ratio of say 20 to 1 at ground level may be less than 5 to 1 when viewed or photographed at altitude on an average day.

The proper use of suitable filters can, so to speak, cut through this scattered blue light or haze and help increase the apparent contrast between the target and its surroundings. The spectral transmission characteristics of yellow and red filters make them suitable for this purpose.

FILTERS FOR BLACK AND WHITE AERIAL PHOTOGRAPHY.—In general terms, for day B&W photography, a yellow filter such as a number 12 should be used at all times on cameras in oblique installations and on panoramic cameras at high altitudes. During heavy haze conditions, a red filter such as a number 25 should be used.

A number 12 filter should be used for most day B&W photography. This filter is used primarily to penetrate atmospheric haze. A number 25 filter is used to penetrate heavy haze or to soften very bright scenes such as areas covered by snow or sand. This filter also enhances general contrast, but with a loss of resolution in low reflectance scenes.

Filters used in black and white aerial photography

| Filter Number | Designation | Color of Filter | Color of light or radiation eliminated | Filter Factor | Use of Filter |
|---|---|---|---|---|---|
| 12 | Minus blue | Medium yellow | Ultraviolet, violet, most of the blue | 2 | Medium-to-high altitude or medium haze conditions; use always with Ektachrome Infrared aero film (CDIR) |
| 25 | Red Tri-color | Red | Ultraviolet, violet, blue-green | 4 | Very high altitude or extremely dense haze |
| 89B | | Visibility opaque | Infrared above 680nm | None | IR sensitive film |
| HF-3 | | Colorless | Blue, green, red | None | Ektachrome color film |
| HF-4 | | Colorless | Blue, green, red | None | Ektachrome color film |
| HF-5 | | Colorless | Blue, green, red | None | Ektachrome color film |

PHOTOGRAPHY.—Filters for aerial color photography are generally used to penetrate atmospheric haze. Haze filters, numbers HF-1 through HF-5, are generally recommended for haze penetration. Selection of the proper HF depends on the severity of the haze. The filter factor for these filters is less than one f/stop. You should refer to the film data sheet for the particular film you are using for additional information concerning both haze filters and other filters.

**Film**

A wide selection of reconnaissance film is available. Particular attention must be given to the proper selection of a film that will meet the mission requirements. During film selection, the mission planners must decide which film will provide the greatest advantages with the least disadvantages. At a minimum the following factors must be considered in selecting the film:

The need for small detail (fine grain film)

Target lighting condition and contrast

Special response film (color, camouflage detection infrared (CDIR), infrared)

Special filteration

Processing requirements

Reconnaissance films are characterized by their sensitivity, base type and thickness, speed, resolution, and granularity.

BLACK AND WHITE PANCHROMATIC FILM.—Black and white panchromatic aerial films are normally sensitive to the visible spectrum. As compared to still picture camera pan film they have additional sensitivity to the red region for greater haze penetration.

BLACK AND WHITE INFRARED FILM (IR).—Black and white infrared aerial film is sensitive to the visible spectrum in addition to infrared. IR sensitivity extends to approximately 900nm with maximum IR sensitivity from about

B&W film to eliminate most of the visible light.

COLOR FILMS.—Color aerial films are of two types: "True" color rendition and "False" color.

- True or normal color aerial films have three emulsion layers. These layers are sensitive to the three primary colors—blue, green, and red. During processing, each layer produces a dye of a complementary color—yellow, magenta, and cyan, respectively. The amount of colorant, or dye, produced in any area is related to the intensity of the light from the original scene. Therefore, each layer is a separate record of the brightness in a single primary color. When white light is passed through a transparency-type film, the combinations of the three dyes produce a close visual reproduction of the original scene colors. In a negative-type color film, the colors of the combined images in the negative will be complementary to the colors in the original scene.

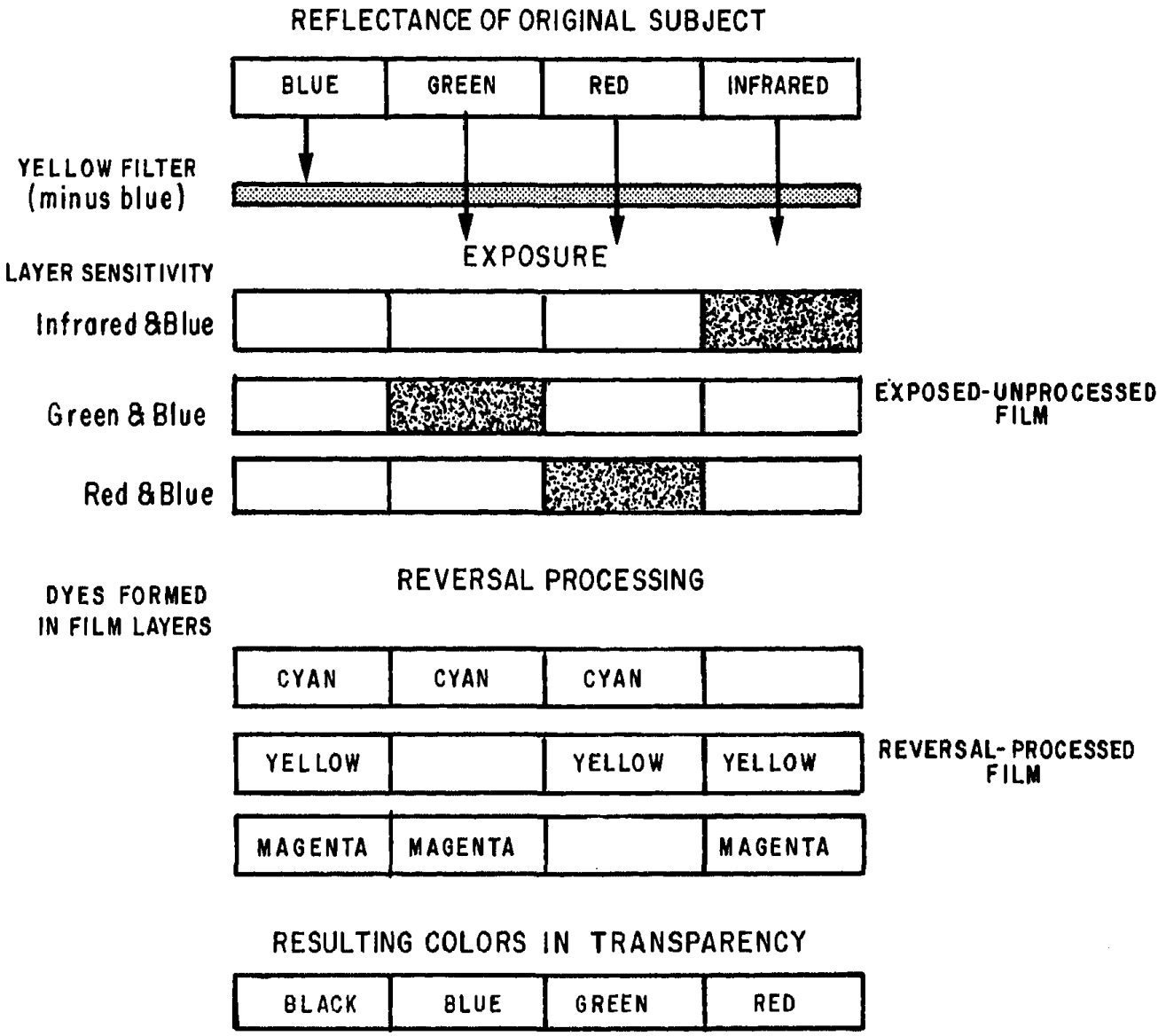
The color rendition in true color films is affected by haze and must be corrected by the use of haze filters (HF) and printing techniques.

- False color or color infrared (camouflage detection infrared (CDIR)) films when exposed through a yellow (minus blue) number 12 filter result in colors which are false.

Any portion of the spectrum to which a film is sensitive can be recorded in a color film if the individual emulsion layer is correspondingly sensitized. The color of the dye formed in any given emulsion layer need bear no relationship to the color of light to which the layer is sensitive. When the relationship is not complementary, the result is false color. False color films are used to emphasize differences between objects that are *visually* very similar. Color IR films emphasize differences in IR reflectance.

The simplified figure shows how the colors in the original scene are reproduced falsely on a color infrared-sensitive film.

As shown in the figure, all three emulsion layers are sensitive to blue. To limit the exposure of each layer to only its intended color, a yellow filter is used over the camera lens. When the




yellow filter is used, the emulsion layers act as if they were sensitive only to infrared, green, and red. This is because all blue radiation is absorbed by the yellow filter.

When IR color film is reversal processed, as usually recommended, infrared radiation appears as red, green reproduces as blue, red reproduces as green, and blue reproduces as black since blue in the original scene was not recorded because of the yellow camera filter. Many other colors are also formed, depending on the proportions of green, red, and infrared reflected from the original scene.

AERIAL FILM SPEED (AFS).—Film speed selection phase of mission planning. A speed-rating method for aerial film known as *Aerial Film Speed* (AFS) adopted by the American National Standards Institute (ANSI) is used to establish the speed of aerial film.

Effective Aerial Film Speed (EAFS).—Sometimes the AFS value obtained with the process specified by the ANSI is different from that produced by the process recommended by the film manufacturer. *Effective Aerial Film Speed* (EAFS) is the term used to describe the speed of black and white negative-type aerial films processed under conditions other than those

Aerial Film Speeds and Effective Aerial Film Speeds should not be confused with ISO speeds because they are not equivalents.

FILM RESOLUTION.—Aerial reconnaissance photographic targets are normally of medium contrast. Basically, slow speed, fine grain films will provide the greatest resolution but proper exposure and development are necessary to retain this film resolution. A scene tonal reproduction of 1:1 (1.0 gamma in the negative) will result in the best medium contrast resolution.

> A good B&W recon negative is one which has been exposed and processed to produce a density in the deep shadow areas of at least 0.05, and not more than 0.25, above gross fog density. In addition, the density scale should have a range of 0.8 to 1.2 with the optimum at 1.0. Any B&W negative which does not meet these criteria will present serious errors in the reproduction of the original scene which indicates errors in exposure (shadow density) and/or processing (density scale of the negative).

## SERIAL FRAME AND PANORAMIC CAMERA PHOTOGRAPHY MISSION PLANNING (EXAMPLES)

When planning a reconnaissance mission where frame or pan cameras will be used, the planners must consider the capabilities, limitations, and characteristics of the cameras—and general information about the mission.

Mission planners can generally refer to published charts, nomographs, and tables for a particular camera/aircraft system. For example, the technical manual, NAVAIR 10-30TARPS-2, *Tactical Air Reconnaissance POD System LA-610*, has many charts and nomographs which refer to the cameras used in the TARPS.

Some of the charts, nomographs, and tables mission planners may refer to are:

- Operational Limits Charts—Operational limits are based on camera system limitations in relation to aircraft ground speed and altitude.

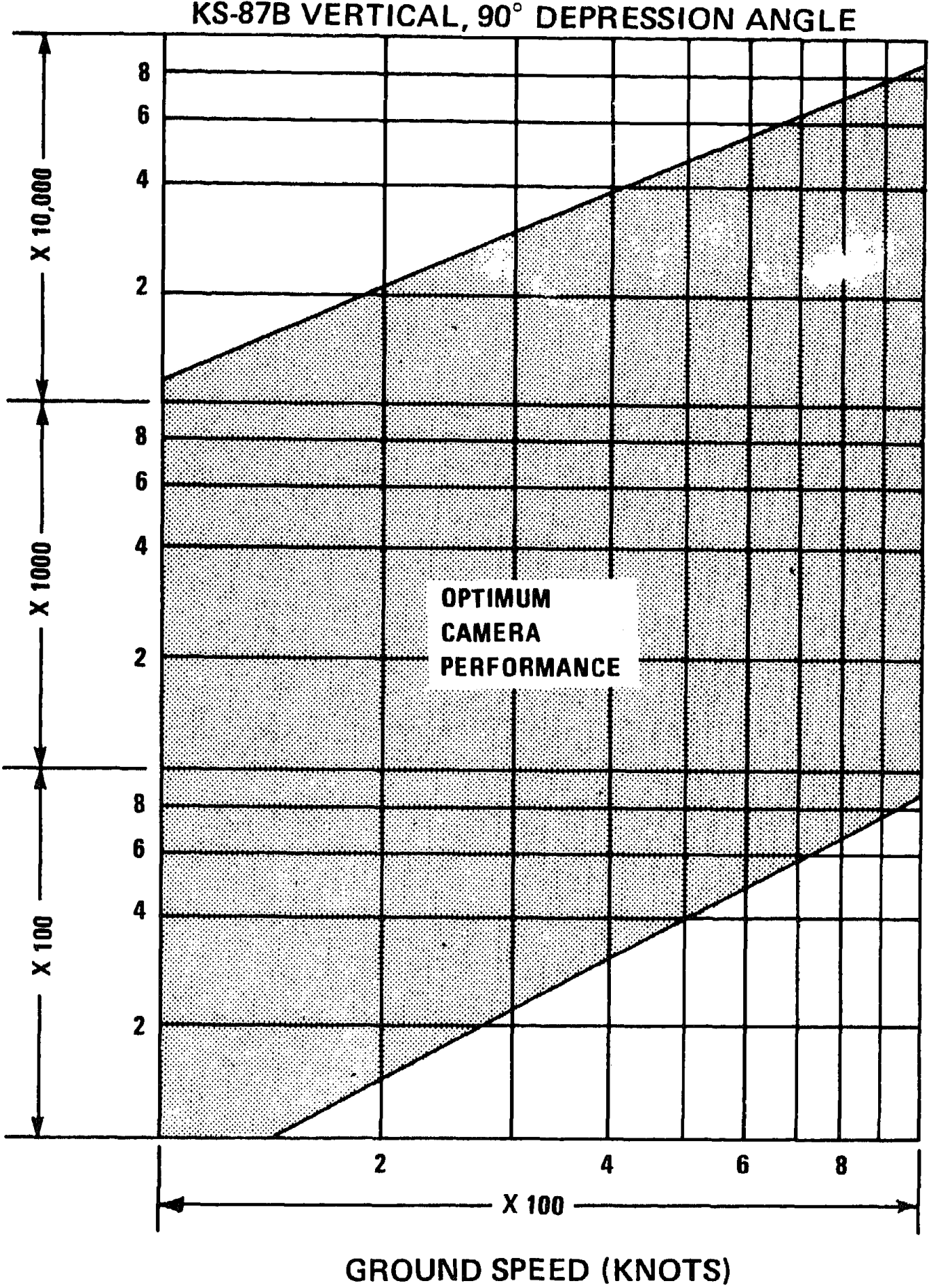
- Lineal Ground Coverage Charts—Lineal ground coverage for a particular camera type and installation is based on aircraft altitude, camera lens focal length, and the amount of film available. These charts may be used to determine the minimum film load required to obtain a particular lineal ground coverage at a specific altitude or to determine the minimum altitude required to obtain a particular lineal ground coverage with a specific film load.

- Angular Ground Coverage Charts—Angular ground coverage for a particular camera type and installation is based on aircraft altitude and field-of-view of the camera. For vertical camera installations, the angular ground coverage extends to the limits dictated by the angular field-of-view of the camera optics, on both sides of the nadir line and also fore and aft of the nadir[1] point. For oblique camera installations, there is a minimum or maximum ground range (depending on the depression angle) which will not be in the field-of-view of the camera. These charts are used as a guide in determining the best camera installation and/or depression angle to be used to ensure that the target of interest will be in camera view.

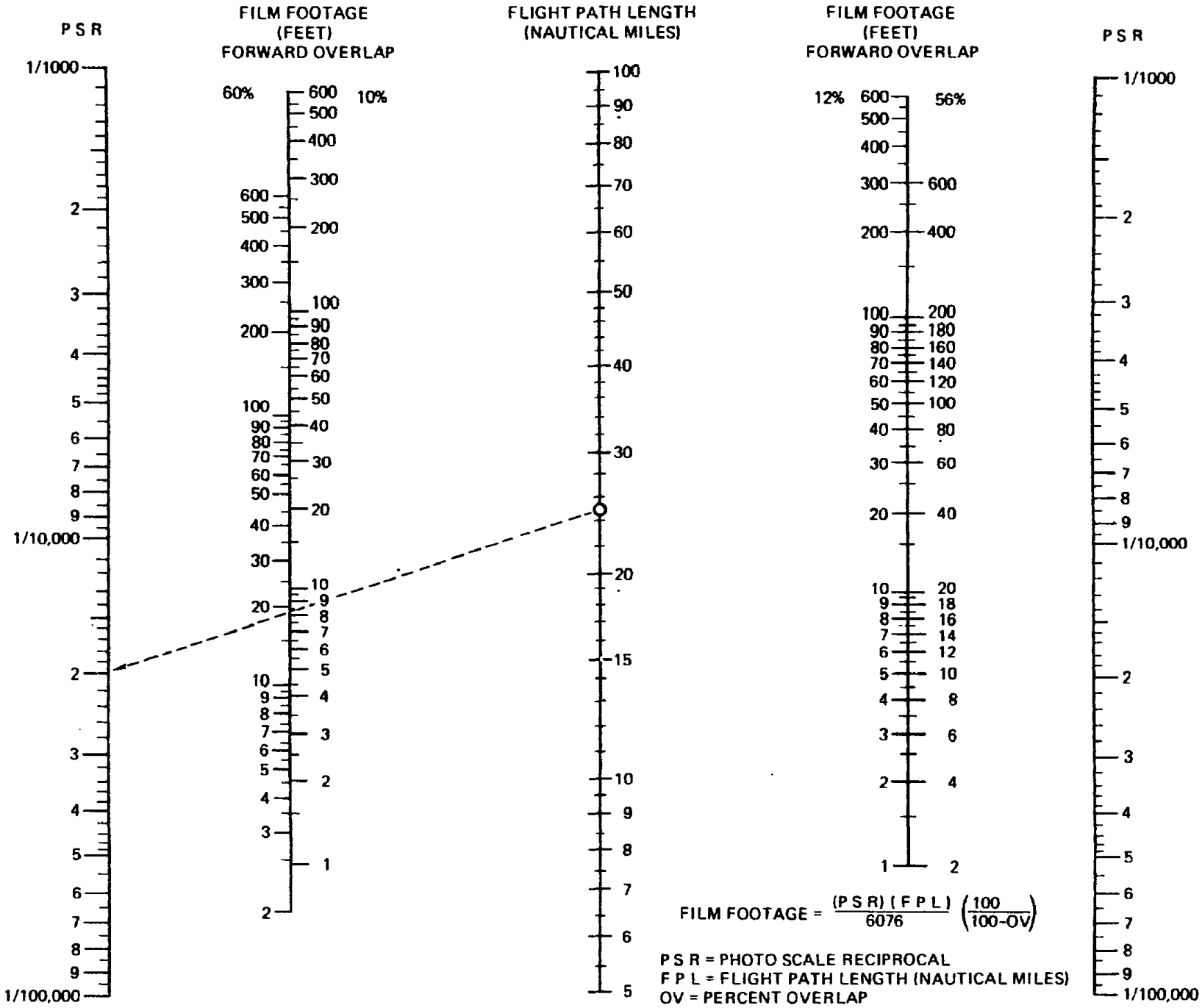
- Area Ground Coverage Charts—Area ground coverage is based on the camera's field-of-view and depression angle and the aircraft altitude.

- Film Usage Nomograph—The rate of film usage can be expressed in feet of film per second or feet of film per nautical mile and number of frames per second or frames per nautical mile. It

[1]Nadir—A point on the ground which is directly beneath the aircraft (or camera) when the aircraft is flying straight and level.




Operational limits chart.




**Film usage nomograph.**

is essential that the film usage rate be considered in reconnaissance mission planning in order to prevent running out of the film before the end of the mission.

● Hyperfocal Distance Table—The hyperfocal distance is the nearest distance at which the lens of a camera can be focused so that all images from that distance to infinity are in sharp focus. Aerial reconnaissance cameras have fixed focus lenses; therefore, the hyperfocal distance translates to the minimum aircraft altitude.

## INFRARED MISSION PLANNING (EXAMPLES)

Mission planners should be aware of the various factors which affect the acquisition of infrared (IR) imagery. Mission planners may have some control over such variables as the flight profile and the time of day the IR mission is to be flown. Often the situation will not permit waiting for optimum weather conditions. Most of the factors which affect the acquisition of IR imagery are not controllable by the mission planners, but knowledge of their effects can influence the mission plan.

### Effects of Time

The following time-of-day factors should be considered.

● Heat from vehicles, generators, cooking fires, etc., can be obscured by solar heating in the daytime.

● The periods shortly before sunrise are the poorest for IR missions since these are times of minimum temperature contrast.

● Maximum solar heating occurs 2 to 3 hours after local noon on a clear day.

● The large difference in radiation between sunlight and shadow areas and the resultant thermal detail may actually obscure targets and indicators of activity that would be detected under the reduced contrast of night cooling.

● During periods of extended heavy overcast, daytime records do not have the thermal detail of imagery obtained on a clear day due to a lack of solar heating. Overcast conditions are usually more favorable for detecting indications of activity (especially fires and vehicle exhausts) than are clear day conditions.

● The nature of the target or activity should be considered. For example, after a barrage of heavy artillery, weapon tubes can remain hot for varying lengths of time.

Hyperfocal Distances in Feet for Aerial Cameras.

| FOCAL LENGTH (INCHES) | ℓ/mm | f-NUMBER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.0 | 1.4 | 2.0 | 2.8 | 4.0 | 4.5 | 5.6 | 8.0 | 11.0 | 16.0 | 22.0 |
| 1.5 | 30 | 143 | 102 | 72 | 51 | 26 | 32 | 26 | 18 | 13 | 9 | 7 |
| | 50 | 234 | 167 | 117 | 84 | 59 | 52 | 42 | 29 | 21 | 15 | 11 |
| 3.0 | 30 | 572 | 409 | 286 | 204 | 143 | 127 | 102 | 72 | 52 | 36 | 26 |
| | 50 | 938 | 670 | 469 | 335 | 234 | 208 | 167 | 117 | 85 | 59 | 43 |
| 6.0 | 30 | 2.289 | 1.635 | 1.144 | 817 | 572 | 509 | 409 | 286 | 208 | 143 | 104 |
| | 50 | 3.750 | 2.679 | 1.875 | 1.339 | 938 | 833 | 670 | 469 | 341 | 234 | 170 |
| 9.0 | 30 | 5.150 | 3.679 | 2.575 | 1.839 | 1.238 | 1.144 | 930 | 644 | 468 | 322 | 234 |
| | 50 | 8.438 | 6.027 | 4.219 | 3.013 | 2.109 | 1.875 | 1.507 | 1.055 | 767 | 527 | 384 |
| 12.0 | 30 | 9.156 | 6.540 | 4.578 | 3.270 | 2.289 | 2.035 | 1.635 | 1.144 | 832 | 572 | 416 |
| | 50 | 15.000 | 10.714 | 7.500 | 5.357 | 3.750 | 3.333 | 2.679 | 1.875 | 1.364 | 938 | 682 |
| 18.0 | 30 | 20.601 | 14.716 | 10.300 | 7.357 | 5.150 | 4.578 | 3.679 | 2.575 | 1.873 | 1.288 | 935 |
| | 50 | 33.750 | 24.107 | 16.875 | 12.054 | 8,438 | 7.500 | 6.027 | 4.219 | 3.066 | 2.109 | 1.534 |
| 24.0 | 30 | 36.624 | 26.160 | 18.312 | 13.080 | 9.156 | 8.139 | 6.540 | 4.578 | 3.329 | 2.289 | 1.665 |
| | 50 | 60.000 | 42.857 | 30.000 | 21.429 | 15.000 | 13.333 | 10.714 | 7.500 | 5.455 | 3.750 | 2.727 |
| 36.0 | 30 | 62.404 | 58.860 | 41.202 | 29.430 | 29.601 | 16.312 | 14.715 | 10.300 | 7.491 | 5.150 | 3.766 |
| | 50 | 135.000 | 96.429 | 67.500 | 48.214 | 33.760 | 30.000 | 24.107 | 16.675 | 12.273 | 6.438 | 6.136 |

just after sunset.

- Night target detection of fires, vehicles, liquid storage tanks, etc., is most favorable 4 to 5 hours after sunset. At this time warm objects near cool surroundings have more contrast on the film.

### Effects of Weather

Infrared systems can be operated with limited success in marginal weather conditions that would be unacceptable for aerial photographic camera systems. However, the following effects of weather conditions should be considered.

- Long periods of overcast reduce thermal contrast and will reduce details of terrain.

- Extended periods of low, heavy overcast produce a condition in which all ground surfaces, the base of the clouds, and the atmospheric paths between them approach the same temperature, decreasing thermal details. Washout of thermal contrast because of overcast usually is most severe during the nighttime.

- Winds of extended duration reduce differential radiant cooling effects, bringing all exposed surfaces to nearly the same level of radiation.

- During nighttime operations, scattered to broken cloud cover does not affect the imagery as it does during the day; however, flight altitude should be below the lowest cloud layer.

- A clear, dry night is best for good tactical target detection and terrain mapping. Such occasions should be exploited whenever possible.

- Of all imagery, that acquired on a clear, dry day will have the most photographic appearance and the best apparent resolution. Its contrast usually will be very sharp because of the large differences in thermal radiation of various objects. However, this should not be necessarily regarded as optimal since extremely sharp contrast sometimes obscure targets or indicators of activity (including fires hidden by vegetation).

- When all surfaces are saturated with water, they radiate with low emissivity. Any contrast must result solely from differential heating and cooling. If all surfaces are saturated immediately after a rain, they may all appear in low contrast. Wind and humidity will affect evaporation, with a degrading effect on the imagery.

- Targets can be detected day or night if there is a difference in temperature and the flight altitude is below the overcast.

### Atmosphere Effects

Infrared radiation is attenuated by atmospheric particles such as rain, fog, snow, sleet, and dust. Under such conditions, the particles reduce the radiation received by the IR detector. Detection becomes increasingly difficult with the presence of atmospheric particles. However, the IR image can be correlated with other sensors but its quality will be degraded.

## RECONNAISSANCE MISSION PREPARATION AND EXECUTION

Beyond the planning of a recon mission is the actual preparation and execution of the mission. In the preparation and execution phase certain tasks must be performed by aircraft maintenance and line crew personnel before a mission can be conducted.

## AIRCRAFT PREPARATION

Before a reconnaissance flight can be conducted, many tasks must be performed by maintenance and line personnel so that the mission can be executed in the planned manner. Maintenance tasks during the aircraft preparation

phase which are of particular interest to PHs include the following:

- Prepare and inspect serial frame cameras
- Prepare and inspect panoramic cameras
- Prepare and inspect infrared detection systems
- Prepare and inspect sensor control panel settings
- Clean aircraft camera windows
- Perform operational checks

**Sensors**

Mission preparation of the sensors may include the following:

Film cassette loading and labeling
General cleaning
Filter installation
Film sensitivity setting
Sensor installation
Sensor control panel settings
Operational checks

**MISSION PLANNING FORM**

PHOTO LAB JOB CONTROL INFO

| CLASSIFICATION 01 | PROJECT NUMBER 02 — 06 | UNIT 07 — NUMBER 09 | MEDIA 14 | O R 18 |
|---|---|---|---|---|
| REQUESTER SUPPLIED INFORMATION ORGANIZATION | NAME OF REQUESTER | UIC 17 | CUSTOMER JOB NUMBER 22 | |
| PHONE | AUTOVON PREFIX | RECEIVED | DATE 45 — 47 — 50 | |
| PILOT | RIO | EVENT | ETD | A C | POD | FLT TIME |
| DATE (DAY MONTH YEAR) | MISSION | SQUADRON | DET | BORTIE |

MISSION DATA

| SENSOR DATA | FRAME CAMERA | PAN CAMERA | IR SENSOR | | |
|---|---|---|---|---|---|
| FILM TYPE | | | | | |
| FILM LOAD | | | | | |
| S/C | | | | | |
| FILTER | | | | | |
| DDS EXP/PW | 1-2-3-4-5 | 10-15-20-25 | 1-2-3-4-5 | | |
| GAMMA | | | | | |

REQUIREMENTS SET BY DAY/TIME

MAINTENANCE

| | | | | | |
|---|---|---|---|---|---|
| CAMERA NO. | | | | | |
| MAGAZINE NO. | | | | | |
| SUPPLY NO. | | | | | |
| TAKE UP NO. | | | | | |
| EMULSION/TYPE | | | | | |
| PRECOUNT | | | | | |
| POSTCOUNT | | | | | |

LAB DELIVERY BY DAY/TIME TO NUMBER

PROCESSING DATA

| | | | | | |
|---|---|---|---|---|---|
| PROCESSOR NO. | | | | | |
| CALIBRATED EPM | | | | | |
| TEMP | | | | | |
| DEVELOPED GAMMA | | | | | |
| QUALITY OF FILM | | | | | |
| FOOTAGE | | | | | |
| DAY/TIME | | | | | |
| PROCESSED BY | | | | | |

FILM PICKED UP BY DAY/TIME

REMARKS

A mission planning form will supply the information needed to perform these tasks.

## CARRIER-BASED INTELLIGENCE CENTER (CVIC) PREPARATION

Prior to the return of the recon aircraft to the ship, CVIC PHs perform a number of essential tasks designed to prepare the intelligence processing system of the CVIC for maximum readiness and utilization.

### Processing Preparation

During the preparation phase, the film processors are checked in accordance with standard quality assurance procedures. Processing solutions, machine speeds, and temperatures are checked with sensitometric tests and verified to comply with processing instructions on the mission planning form. Each CVIC should develop a family of curves for each film type and emulsion batch used reflecting the parameters of the chemistry and processors in which the mission film will be processed. Film processing in accordance with instructions established during mission planning is considered critical. Camera exposure settings are made based on the expected response (speed) of a particular emulsion when developed to a specified gamma in a particular type of chemistry at a specified temperature. Deviations from the planned processing parameters will affect the degree of development of the imagery and may render the imagery unusable.

QUALITY ASSURANCE.—The need for maximum intelligence information and the risks involved in the collection of information by airborne sensors make it mandatory that a high standard of quality be established and maintained in film processing. The constant production of high-quality work requires control over all conditions affecting sensitized materials, and in all steps in the processing, printing, and handling of these materials. Quality assurance in film processing is accomplished through the use of standards, established as references, and a monitoring system for systematic comparison of daily production to these standards.

Standard sensitometric practices may be used to maintain day-to-day control of machine processing. Overall readiness of machines and solutions and exact operating rates to achieve the desired gamma may be determined by sensitometric tests and time gamma curves, charts, or tables. Reference standards may be prepared on the film types commonly used, and standard procedures used for systematically monitoring the processes. Control records or plots may be established to assist in maintaining uniformity in processing from day to day. One of the most important factors affecting processing quality is the condition of the processing solutions. An important requirement for the control of the processing solution is the proper mixing of chemicals and correct use of the processing and replenishing solutions.

Certain forms and records can be considered essential to film processing of a standard required in support of intelligence reconnaissance imagery.

MISSION PLANNING FORM.—Mission planning forms define the work to be done, types of film to be used, processing requirements, priority, classification, etc. They should accompany each job received for film processing. The use of such a document will minimize costly errors in film processing that may result from lack of sufficient information or misunderstanding verbal information.

CONTROL PLOTS AND RECORDS.—Control plots or records are useful in maintaining uniformity in processing from day to day by providing directions and exact amounts of deviation from the normal and indicated corrective action.

AERIAL FILM PROCESSING LOG.—Aerial film processing logs of all job orders received for processing recon film provide historical quality assurance data on all recon flights.

## RECONNAISSANCE IMAGERY PROCESSING STANDARDS AND PROCEDURES

With our modern naval aircraft flying lower and faster, maximum film speed must be

**AERIAL FILM PROCESSING LOG**

| Non No | Time/Date Enter P/P | SCD No | Sortie No | A/C No | Sen ID | Film Emul | Gamma | Tank | FPM | Mech No. | Footage | Recon /Line Notified | Film Qual | CMB's | Remarks Film Defects, CMS Problems Etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |

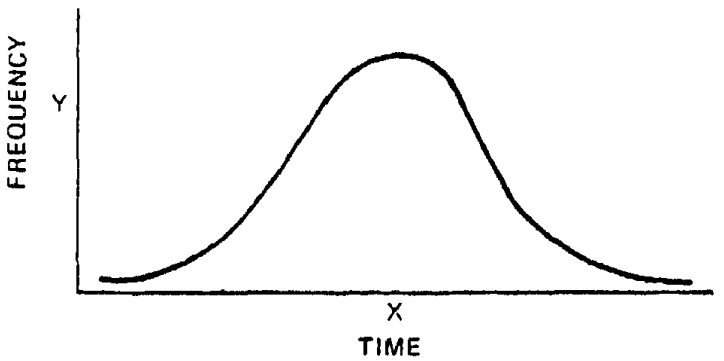
maintained at all times in order to use the fast shutter speeds needed to prevent image blur. In order to maintain this film speed, processing must be rigidly controlled. The film is the end result of many man-hours of careful planning and execution. Unless the finished product is of the highest professional quality, the mission worker's time and efforts have been wasted.

## ESTABLISHED CVIC PHOTOGRAPHIC PROCESSING STANDARDS

Photographic processing standards, as established for CVIC photographic processing, use laboratory variations and statistical quality assurance techniques to achieve and maintain the desired image quality.

Variations in laboratory operations must be expected as perfectly natural events and will always be present. Statistical quality assurance is based on the proposition that variation cannot be eliminated, but can be controlled within predictable limits. The establishment of this control within these predictable limits will improve the quality of the image-forming intelligence data gathered. Variations, if properly recorded, fall into a pattern. Thus, a series of unpredictable events (variations) may be brought together into

designed as bell-shaped or normal curves. Exposure time, light source, storage of film, chemistry, development time, temperature, and agitation are the factors that influence the shape of the curve. The bell-shaped pattern, or curve, is based on expectation. That is, the patterns are calculated on the assumption of a set of possible outcomes as being equally probable, or as having specific probabilities. This idealized limiting distribution is represented by a frequency distribution which is smooth, symmetrical, extending indefinitely far to the right or left, approaching (but never reaching) the X-axis.




**Sample normal (bell-shaped) curve.**

The photo processing crew is the key to success or failure of the entire reconnaissance mission. The quality of the resulting photography is dependent upon the quality of processed images which is, in turn, dependent upon the sailors involved with the mission planning. Two important photographic processing facts must be considered when planning an intelligence data collecting mission. The end product desired and what constitutes optimum quality of that end product must be established if the processing crew of the CVIC is to obtain the high quality desired. Mission planning must attempt to control the variation produced by cameras and film processing equipment (mechanical) and the personnel (human) factor in maintaining and preparing the various equipment used in photo processing. Product uniformity or quality may be obtained when the techniques of photographic process quality assurance are employed. These techniques consist of three basic steps—process specification, process evaluation, and diagnosing processing trouble. The third step (diagnosing trouble) consists of diagnosing trouble when the process specifications are not being obtained. Once the trouble has been isolated, it then becomes necessary to correct the cause, be it chemical, mechanical, or human.

## Process Specification

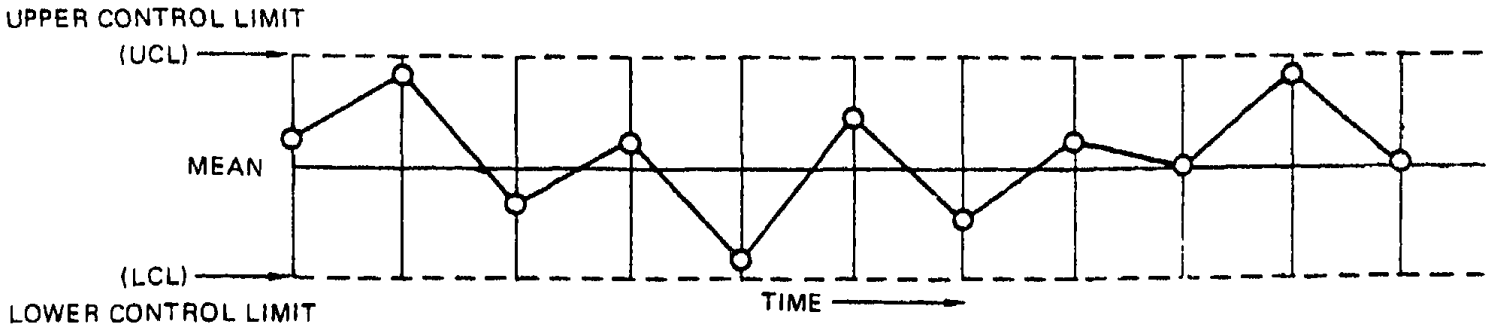
Film manufacturers produce film designed to accomplish a certain desired image-reproducing result. The film and its end result are predicted on the use of a predetermined developer, time, temperature, etc., combination used in processing the film. Other combinations of developer, time, temperature, etc., that will produce the optimum quality end product may also be used.

These combinations should be known, considered, available, and used as the situation warrants. Care should be taken that these other developer combinations have been tested and proven, and are properly plotted on charts or other records for comparison and use.

The selected developer must be capable of producing reproducible results. The processor must provide a uniform distribution of the developer solution equally on all surfaces of the exposed light-sensitive material. If uniform development is to be achieved, standards and control of processing temperature (solution and drying air), time, developer solution (chemistry), and a uniform method of agitation must be established. The need for control charts should be determined and established at this point. A decision as to what measurements of the process are to be used is in order. It should be pointed out that a control chart can deal with only one characteristic at a time in film processing. Normally separate charts will be constructed for fog, speed, gamma, temperature, pH, density, and other variables.

## Process Evaluation

A continuous process evaluation consists of those operations that will ensure instrument accuracy, acceptable equipment performance, and proper processing within established standards and limitations. These operations are covered by




**Sample control chart.**

the function to be performed. These functions are pre-mission validation, mission processing, and post-mission evaluation.

PRE-MISSION VALIDATION.—Pre-mission validation consists of those tasks that must be performed on the CVIC system prior to processing mission material. These tasks are performed to ensure that the system is operating satisfactorily within the acceptable, established limits for that particular mission. Five tasks that must be done prior to mission processing are:

- The meteorology or measuring equipment (densitometers, scales, meters, etc.) must be properly calibrated to ensure valid, reliable data.

- The processing, printing, and support equipment must be certified as operating properly to produce the desired photographic results and to prevent physical damage to the photographic material.

- The composition of the chemical solutions must be verified to be correct prior to processing mission material.

- The sensitometric properties of the photographic material, and its related control stock, must be correlated and certified to be within established standards.

- The facility and environmental standards necessary for maintaining the desired photographic image quality must be verified.

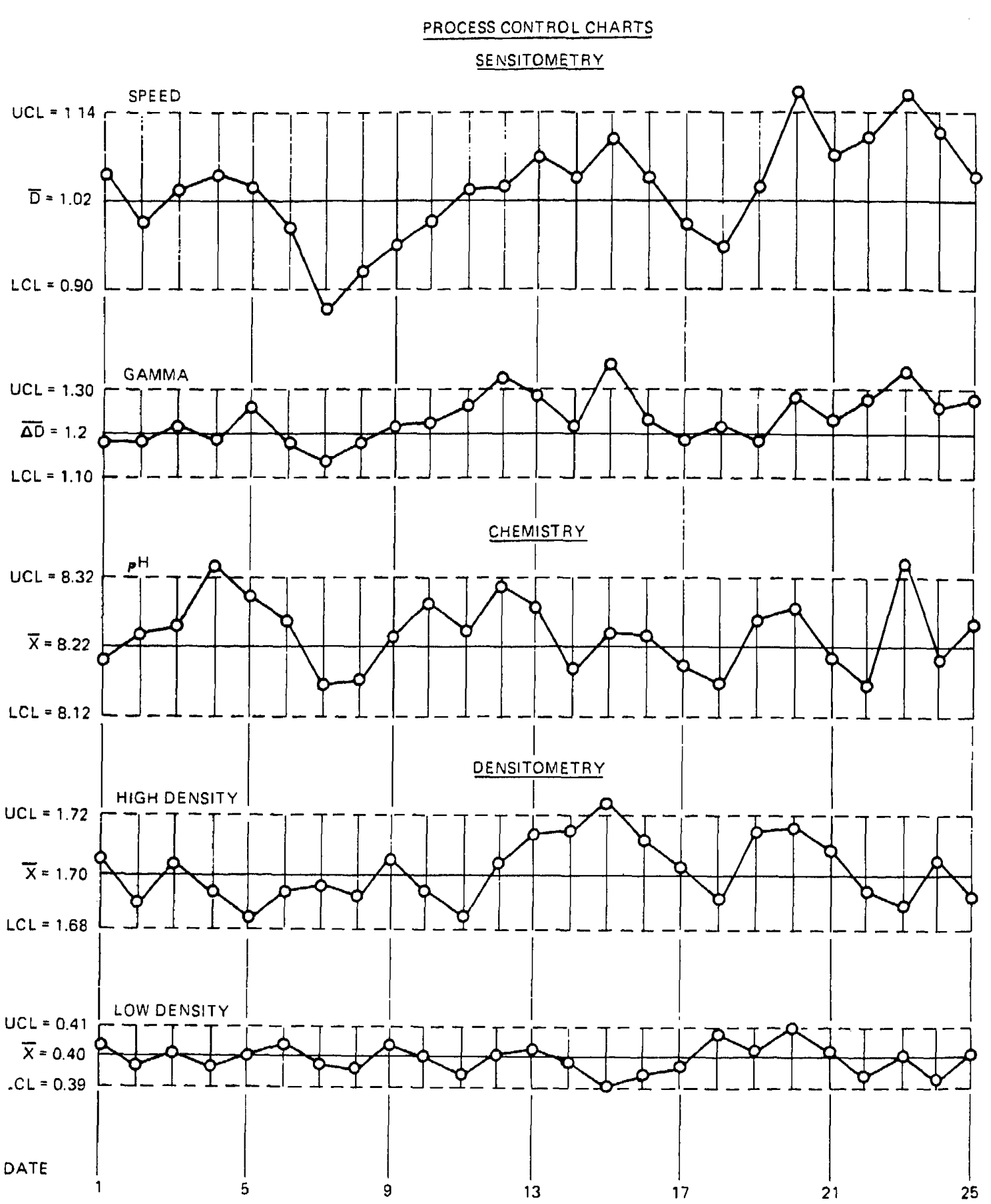
MISSION PROCESSING.—The adequacy of the mission processing facilities, equipment, solutions, and procedures must be certified before the actual processing of mission material begins. Mission processing procedures normally include:

- Receiving operations—Represents an inventory of the contents of all incoming work, a check of actual contents against the job orders, photographic log or similar document, and the recording and reporting of any discrepancies. Where applicable, all film cans, cartons, cases, or other containers are thoroughly cleaned before introduction into the clean room areas. Necessary administrative action is taken to log in the work and prepare any locally required work orders and/or other documents.

- Pre-processing production inspection and preparation—The material to be processed or reproduced (original negative and duplicates) must be inspected for physical defects and otherwise made ready for machine processing. Defects such as tears, crimped film edges, defective splices, and other damage that could prevent proper transport of the material through the processor must be corrected.

- Process specifications—The level of excellence required must be determined and photographic image quality standards established; i.e., the process specification must be prepared for original negative and/or duplicating material. Processing requirements for the original negative are normally determined from information contained in the mission planning form or from specific directions of the customer.

- Film processing and reproduction—The point of no return in the photographic process is


PROCESS CONTROL CHARTS
SENSITOMETRY
SPEED
UCL = 1.14
D = 1.02
LCL = 0.90
GAMMA
UCL = 1.30
ΔD = 1.2
LCL = 1.10
CHEMISTRY
pH
UCL = 8.32
X = 8.22
LCL = 8.12
DENSITOMETRY
HIGH DENSITY
UCL = 1.72
X = 1.70
LCL = 1.68
LOW DENSITY
UCL = 0.41
X = 0.40
LCL = 0.39
DATE
1
5
9
13
17
21
25

the developing solution. Control of the degree and uniformity of development is still possible, but there is no turning back. Basically, success depends on an ability to establish specific sensitometric aimpoints and repeatability to carry out known procedures that will allow processing to meet these predetermined goals. The processing operation must be continually monitored in all its aspects, and adjustments made as needed, to ensure that the process specifications are maintained; i.e.:

- The film is processed in a certified processor. (A sample of the mission or mission-type material has previously been processed, evaluated, and certified as meeting the specifications.)

- The film tracks properly through the machine at the proper speed without incurring physical damage.

- The processing solutions have been certified and are maintained at the specified temperature and replenishment rate; specified rates of agitation and/or recirculation are also maintained.

- The drier operates properly; i.e., film trackage and transport rate; temperature and humidity are within specific tolerances.

Film Handling.—Careful handling of the film, especially prior to and during processing, is important for producing professional quality images. Keep the following points in mind.

- The surrounding environment during operations such as camera loading and unloading, rewinding, presplicing, and machine feed-on should be dirt free. These functions should, if possible, be carried out in areas provided with filtered, conditioned air and used exclusively for the purpose listed. In particular, very fine metallic or dirt particles must not be allowed to become embedded in the emulsion surface.

- Film should not be exposed to oils from the skin or to lubricants from equipment. Wear clean white cotton gloves when handling film.

- Film should be protected from exposure to water condensation or vapors from the processing solutions.

the buildup of static charges, electrical discharges can expose and fog the film.

- Avoid applying excessive force to the film surface. Abnormal stresses can cause pressure sensitization.

- Follow carefully the instructions concerning the storage of film (before and after exposure).

Film Inspection and Splicing.—Film should be inspected for edge damage such as tears or wrinkles prior to processing. This can be done by slowly rewinding the exposed roll of film while feeling the edges of the film for defects. Wear clean white cotton gloves for this operation and allow only the film edges to pass between your thumb and forefinger.

Film inspection and splicing must be done in a dust-free, totally dark area, and special care should be taken in handling the film and making properly aligned splices. For making proper film-to-film or film-to-leader splices, always follow the operator's instructions for the particular aerial film splicer you are using. Making splices between films or leaders of different widths is not recommended. Splices should not be left in the machine solutions for an extended period of time because the solutions may cause deterioration of the tape and subsequent failure of the splice.

Leader Tabs.—Whenever a roll of recon film is fed into an unleadered processing machine, the beginning, front, or leading end of the film must be guided in the proper path by a piece of leader tab. A piece of 7-mil Estar base film can be used as a leader tab. Processed X-ray film works well also. Except when used to lead a control strip, the leader tab should be cut down to the same width as the film to be processed. The leader tabs should be about 12 inches long.

Avoiding Scratches.—There may be some tendency, particularly with acetate-base materials, for very fine base scratches to form on the beginning and trailing ends of continuous lengths of film that are attached directly to a leader tab. These minor scratches are caused by insufficient tension on the film when the machine is not completely threaded from feed to takeup. Although these scratches are not objectionable for most

purposes, they can easily be avoided completely in the following way:

- Attach a length of Kodak black aero leader, sufficiently long enough to completely thread the processing machine from feed to takeup, to the leader tab. Splice the film to be processed to the other end of the black leader and let it follow the leader through the processor. To avoid scratches at the trailing end of the film, presplice black leader onto this end, again in sufficient lengths to completely thread the machine.

In addition, it is a good idea to check for more severe scratching, such as that caused by a defective roller, before processing the film. A scratch test roll can be prespliced and fed into the processors following the control or sensi-strip. Such a roll can be prepared from a long strip of black aero leader attached to a leader tab, followed by 3 to 5 feet of film that is known to be scratch free, followed by another long strip of black leader. If acceptable physical quality is not obtained, the cause of the defect will have to be traced to the source and corrected before original film is processed.

## POST-MISSION IMAGE EVALUATION

After processing, the mission film is subjected to stringent post-mission evaluation which serves the following purposes:

- It determines whether or not the process has produced the desired sensitometric goals and provides a feedback for process adjustments.
- It reveals improper procedures or techniques and defective materials.
- It identifies Malfunctioning equipment.

The post-mission evaluation should include three phases.

Physical Damage—The entire mission product or film is inspected for exposure damage or defects to the imagery such as fogging, streaking, pinholes, and shadows caused by particulate matter which may have been in the camera or on the aircraft camera window. Also look for superficial defects such as film tears, dirt, scratches, abrasions, or foreign marks, etc. The defects should be described and reported as to the actual frame position to assist in the identification of improper handling, processing, or other lab or maintenance procedures.

Image Analysis—Density measurements are made with a densitometer. Properties evaluated should include D-min, D-max, density range, and gross fog. Film resolution using a microscope is also determined.

Laboratory Evaluations—If possible, samples of unexposed sensitized materials used in the mission should be obtained and used to produce sensitometric measurements and standards for comparison with the mission film after processing. A small sample of the processed mission material (nonimage) is removed and chemically evaluated to determine archival quality. Either the Kodak Hypo Estimator Test or the ANSI PH4.8-1978 is recommended for this test.

Undesirable reconnaissance negative conditions.

| CONDITION | POSSIBLE CAUSE |
|---|---|
| Fuzzy definition | Out of focus |
| Blurred all over | Movement of camera |
| Flat and much shadow detail | Overexposed |
| Contrasty | Overdeveloped |

Undesirable reconnaissance negative conditions—Continued.

| CONDITION | POSSIBLE CAUSE |
|---|---|
| Lacking shadow detail | Underexposed |
| With shadow detail but lacking contrast | Underdeveloped |
| Dark areas with images of lens diaphragm | Light scatter |
| Black blobs with images of lens diaphragm | Lens flare |
| Black splashes | Light leak in camera |
| Splashes of greater density | Water or developer splashes before or after development |
| Black fingermarks | Developer-contaminated fingertips |
| Black edges (rollfilm) | Edge fog |
| Dark or degraded edges | Damp storage |
| Fine black lines | Abrasion marks |
| Black spots | Chemical dust |
| Dark ribbonlike tangle | Sun tracks |
| Tiny dark arrow-shaped mark, accompanied by dimpling of film negative | Kink |
| Very short, rather faint hairlines close together all over rollfilm negative | Cinch marks |
| Clear areas or areas of lower density | Film contaminated with fixer prior to processing |
| Sharply defined blank area | Obstruction within camera |
| Clear fingermarks | Greasy or fixer contaminated fingers |
| Irregular clear spots | Developer scum |
| Picture fades into transparency at corners | Lens circle of illumination not covering film area |
| Clear scrape marks—emulsion removed | Abrasion |

| CONDITION | POSSIBLE CAUSE |
|---|---|
| Emulsion removed or loosened at edges | Frilling |
| Large spots of lighter density with greater density at edges | Drying mark |
| Irregular—shaped small clear spots | Dust on film during exposure |
| Round spot, either clear or of light intensity | Air bells during development |
| Dappled marking which can also be seen as reflected light | Old material |
| Defined mottle without physical marking of surface | Exposure or fog through backing |
| Defined pattern with physical marking of surface | Reticulation |
| Insufficient density with some veil over shadow | Exhausted developer |
| Brownish appearance of black | Inadequate fixation |
| Obscuration of the picture to a greater or lesser extent | Light fog or chemical fog |
| Dark halo around highlights | Halation or irradiation |
| Two images on same negative | Double exposure |
| Positive or partial positive instead of negative (extreme density) | Reversal due to fogging by extreme overexposure |
| Torn or cockled edges (rollfilm) | Misalignment in camera |

Undesirable print conditions.

| CONDITION | POSSIBLE CAUSE |
|---|---|
| Abrasion or stress marks:<br>Fine lines<br>Hairlike markings<br>Gray patches | Improper handling of sensitive paper (before development); printing apparatus has protruding metal part; negative corner (edge) scratched emulsion surface |

Undesirable print conditions—Continued.

| CONDITION | POSSIBLE CAUSE |
|---|---|
| Blisters | Wide variations in temperature of developer, fixing bath, and washing water; fixing bath too strong; too long immersion in fixing bath |
| Excessive contrast | Usually wrong printing filter; underexposure and over-development of print |
| Lacing contrast | Partially exhausted or improperly compounded developer; developer temperature too low; overexposure followed by short development |
| Deposits on dry prints:<br>Hard water<br>White water | Surface of wet print not wiped before drying; insufficient washing after mixing |
| Fading or tarnishing | Incomplete removal of unused silver salts by fixing bath; failure to remove all hypo |
| | Impurities in mount acid mountant, impure atmosphere |
| Fog or degraded whites | Exposure to light or an unsafe darkroom light before or during printing or developing; prolonged development (beyond usual time) |
| Fog or degraded whites | Developer temperature too high; using an incorrectly prepared developer; developer with insufficient potassium bromide; unsuitable storage area |
| Mottle or patches | Bad storage of the sensitive paper; failure to keep print moving in developer, fixing, or other bath |
| Spots (white—other than those caused by negative defects) Black or white spots, dark spots, blue spots (sulphide toning) | Air bells forming on surface of print during development; particles of dust or chemicals (particularly hypo) falling on surface of paper; air bells formed during fixing; contamination by iron rust. |

## DUPLICATING

There are two methods of producing high-quality reproductions or positive and duplicate transparencies of black and white reconnaissance film. One is the specific tone reproduction method whereby the characteristic curve of the original negative density range is matched to the curve of the duplicating material being used. The second method is simpler and more feasible for shipboard use. This method is called the *trigradient tone reproduction method* or the *1.0 print gamma method.*

The following criteria are recommended as a *guide* to optimum photographic quality and product uniformity in the production of successive duplicate positives or negatives from original aerial reconnaissance negatives. The overall objective of these recommendations is to ensure that a maximum amount of intelligence information can be retained in an optimum form.

- The straight line portion of the characteristic curve of the duplicating or printing material must be used.

  —For most duplicating films, the straight line lies between densities of 0.40 to 1.80.

  —In the duplicate, the minimum image density should be close to 0.40 and the maximum image density should be no more than 1.80.

- Normally, the contrast of the duplicate is correct when the density difference between the highlight and shadow falls between 0.80 and 1.20, preferably near 1.00.

The requirement for using the straight line will be met if the exposure level of the printer is correct. The contrast requirement will be met if the processing is correct. Specifically, the contrast of the duplicate can be increased or decreased relative to the original by increasing or decreasing the processing gradient respectively. In order to achieve these goals, some form of tone control must be exercised to guide the printing and processing operations. The duplication of aerial reconnaissance imagery requires that exacting standards and controls be imposed to ensure that the imagery is of the highest possible quality.

### Trigradient Tone Reproduction

The trigradient tone or 1.0 print gamma reproduction method of duplicating is an objective method for determining printing and processing requirements. This method enables the CVIC photo crew to select one of three standardized processes. Each process produces a different contrast or gradient. The processing requirement is determined by selecting one of the three processes relative to whether the density range of the duplicate should be increased, maintained, or decreased with respect to that of the imagery to be altered, if necessary, in each generation so that the density range of the final product more nearly conforms to the desired tonal values (usually based upon a D-min of 0.40).

TONE CONTROL CURVES.—The trigradient tone reproduction method is based on a set of tone control curves:

High contrast

Medium contrast

Low contrast

Each set of curves consists of a series of response curves that graphically display the tones that are produced in the duplicate when a step tablet or wedge used to simulate the densities of the image to be duplicated is printed under various conditions. Each curve is labeled with the amount of neutral density used in printing. These response curves enable the density range of the imagery to be altered so that the density range of the final product more nearly conforms to the desired density difference (1.0). The exposure on the printer is of utmost importance since it determines the placement of the tonal values of the imagery being reproduced on the sensitometric response curve of the duplicating material. Ideally, all tones should fall on the straight line portion of the response curve to ensure reproduction in a uniform, linear manner. Most duplicating films do not have a linear response so the straight line

and upper toe portions of the response curve are used. The maximum useful density of imagery to be duplicated is used as the basis for computing the required exposure since it will be reproduced as the minimum useful density in the reproduction.

TRIGRADIENT TONE REPRODUCTION PROCEDURES.—To use the trigradient tone reproduction method proceed as follows:

1. Obtain the three sets of tone control curves (high, medium, and low contrasts) for the particular duplicating materials to be used.
2. Determine the minimum and maximum useful densities from the roll of imagery to be duplicated.
3. Compute the density difference and determine if the tonal range should be increased, decreased, or retained in order to obtain the desired density range (usually 1.0).
4. Based upon results of step 3, select the appropriate set of response curves to be used (high, medium, or low).
5. Determine the D-min aimpoint for the duplicate, usually 0.40.
6. Locate, on the tone control graph, the intersection of the projections of the D-min aimpoint and the useful D-max of the imagery that is to be duplicated. The printing instructions to be used are those that were used to expose the response curve which passes through the intersection.
7. Interpolate to compute the precise value if necessary.
8. Process the imagery in the same manner as that received by the samples from which the tone control curves were obtained.
9. Densitometrically evaluate the processed material to determine if the desired tonal relationships were obtained; i.e., the desired D-min and D-max values.

The entire tone control system is based upon data produced when the system was established. In order for the system to be accurate and reliable, all of the major variables must be controlled so that they can be carried out on a repeatable basis for many months.

## PRINTING

### Characteristic Curve of Paper

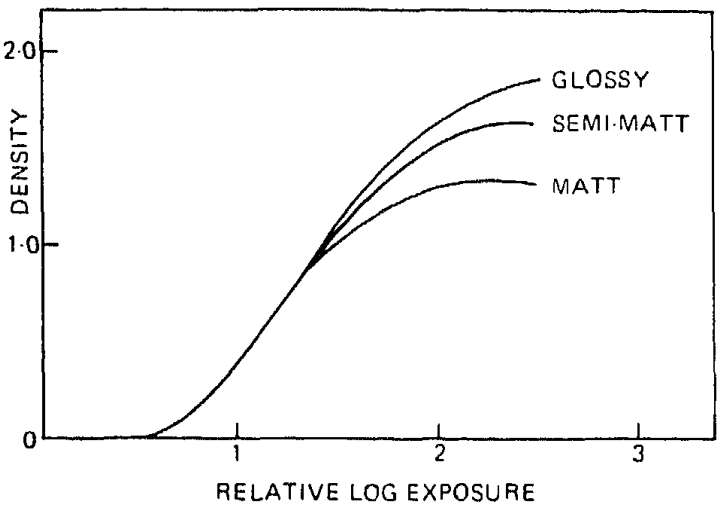
The characteristic curve of a photographic paper is obtained in the same way as that of a film, by plotting density against log exposure. Density in this case is reflection density, not transmission density.

The characteristic curve of a paper, like that of a negative material, can be divided into three main regions: toe, straight line, and shoulder.

The main differences between the curve of a paper and that of a film are:

1. The shoulder of the paper is reached at a relatively low density and turns over sharply, the curve becoming parallel to the log E axis at a D-max which rarely exceeds a value of 2.0.
2. The toe extends to a fairly high density; i.e., is long.
3. The straight line portion is short—in some papers, nonexistent, the toe running into the shoulder.
4. The slope of the straight line is generally quite steep compared with the same emulsion on film.
5. Fog, with normal development, is absent.

Inadequacies between differences 2 and 4 arise from the fact that when a silver image on a paper base is viewed by reflected light, the effective density is increased, because light must pass twice




**Characteristic curves of paper.**

through the image. The practical consequences of difference 1 are that the maximum density obtainable on any paper is limited, however long the exposure or the development. The highest value of density which can be obtained for a particular paper with full exposure and development is called the maximum black of the paper. The maximum density obtainable on any given paper depends principally on its surface. Light striking the surface of a print undergoes three phases of reflection:

- Part of the light is reflected by the surface of the gelatin layer in which the silver grains are embedded.

- Part is reflected by the silver grains themselves.

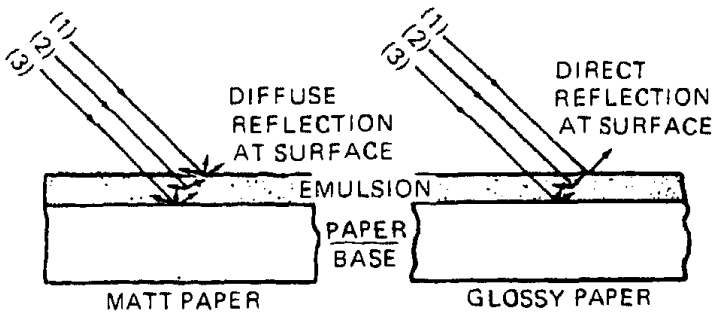
- Part is reflected by the surface of the paper base itself.

It is the sum of these three reflections that determines the reflection factor and hence the density of the print. By increasing the exposure received by a paper, and thus the amount of silver in the image, we can eliminate entirely the reflection from the paper base, but reflections from the gelatin surface of the emulsion and from the individual grains cannot be reduced in this way. These reflections, therefore, set a limit to the maximum black available. The value of the reflection from the surface of the emulsion depends upon the nature of this surface. A print will normally be viewed in such a way that the specular reflection from the surface does not enter the eye. Therefore, diffuse reflection is the only concern. Now, the reflection from the surface of a glossy paper is almost entirely specular, so that the amount of light reflected from the surface of such a paper which enters the eye when viewing a print is very small indeed. In these circumstances, the limit to maximum density of the print is governed principally by the light reflected by the silver image itself. This is usually a little over 1 percent, corresponding to a maximum black density of just under 2.0.

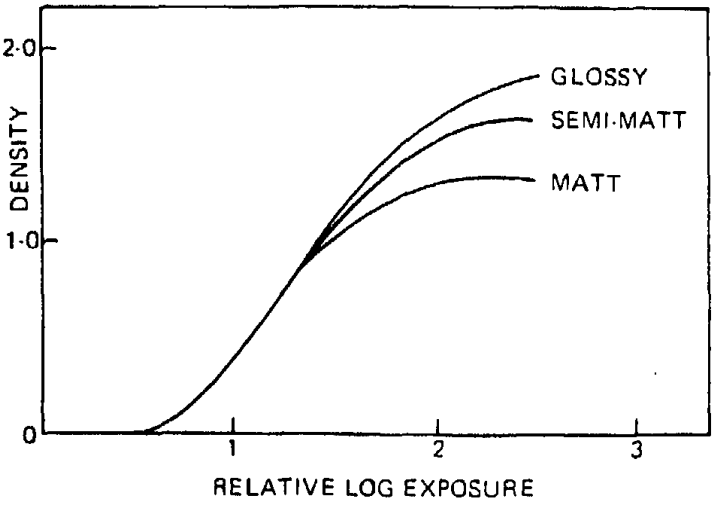
The reflection from the surface of the matte paper, on the other hand, is almost completely diffused, so that an appreciable amount of light (e.g., 4 percent) from the surface of the paper reaches the eye, in addition to the light from the silver image. The maximum black of a matte paper is, therefore, relatively low. Semimatte papers have maximum blacks between that of glossy and matte papers. The following reflection densities are typical of the values of maximum black obtainable on papers of the main types of surfaces.

| SURFACE | REFLECTION DENSITY |
|---|---|
| Glossy | 1.80 |
| Semimatte | 1.65 |
| Matte | 1.30 |

The effect of variation in maximum black on the characteristic curve is confined largely to the shoulder of the curve, as shown here.




**Paper surface reflection characteristic.**



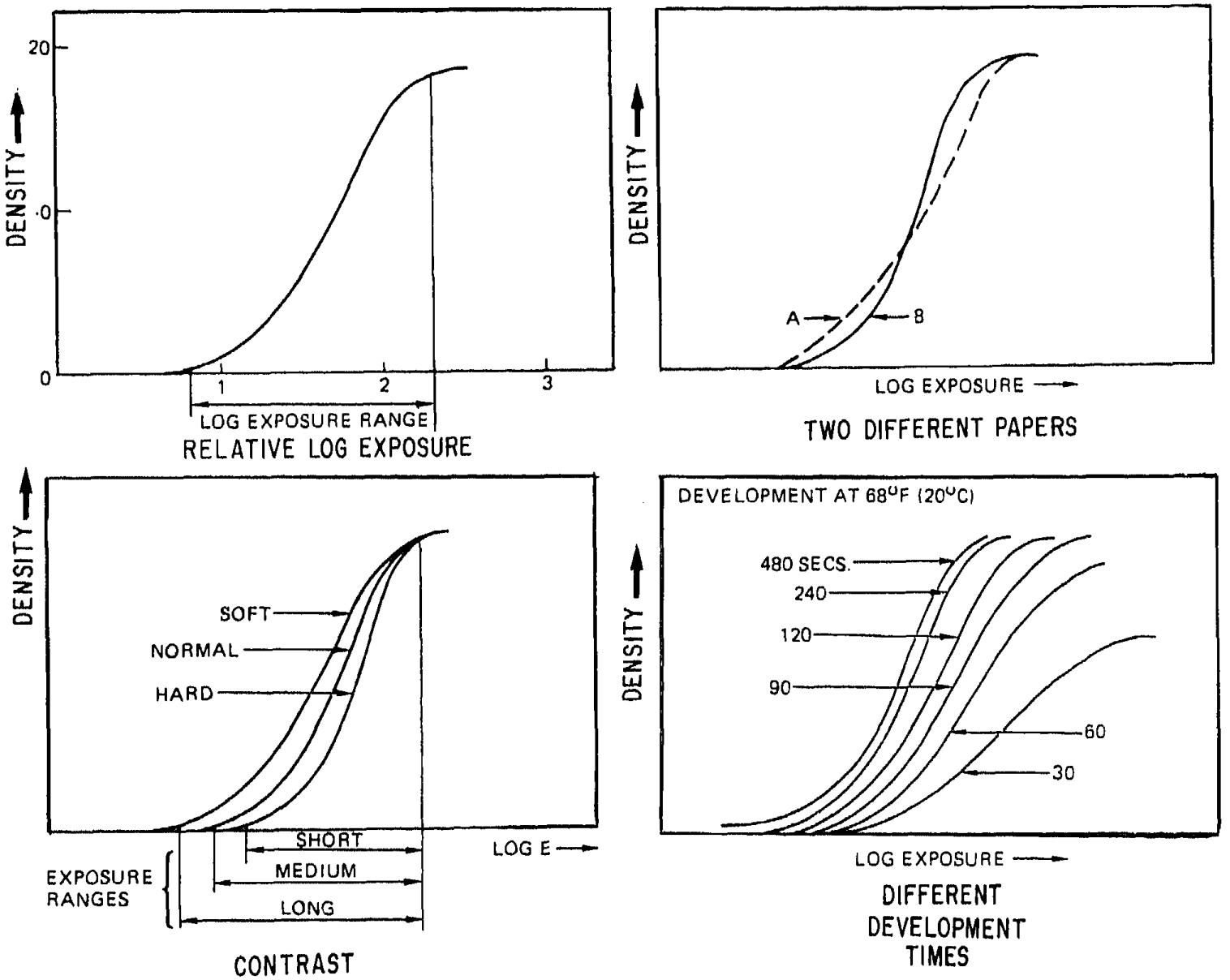

**Characteristic curves of paper.**

The ratio of the exposure corresponding to the highest and lowest points on the curve employed in a normal print is termed the *exposure range* of the paper. This may be expressed either in exposure units or in log exposure units.

**Paper Image Contrast**

In printing reconnaissance film, it is desirable that all the negative tones appear in the print, and that the print should show the full range of tones, between black and white, that it is capable of producing.

In printing, the exposure of the paper is governed by the negative densities; the greater the density of any negative area, the less exposure received by the paper, and vice versa. In order to meet print tone reproduction requirements, the exposure through the highlight areas of the negative must correspond with the toe of the curve of the printing paper, and the exposure through the shadow areas of the negative must correspond with the shoulder of this curve. Expressed sensitometrically, this means that the log exposure range of the paper must equal the density range of the negative. Not all negatives have the same density range: this varies with the brightness range of the subject, the emulsion used, the exposure, and the degree of film development. Therefore,



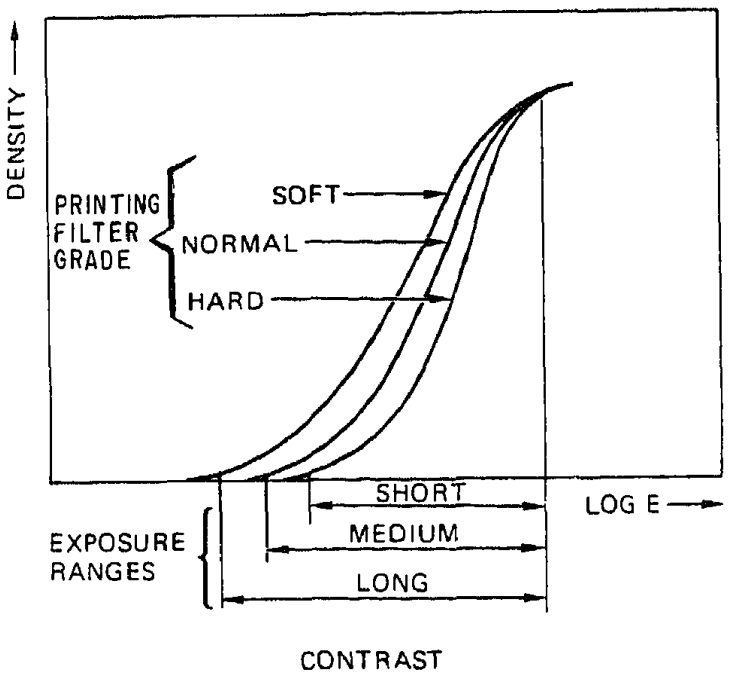

**Paper-characteristic curve samples.**

different filters are used with variable contrast printing paper to enable the CVIC photo crew to produce the required tone reproductions.

The three curves reproduced here all show the same maximum black, but the steepness of the curve increases and the exposure range decreases as proceeding from the soft to hard printing filters.

Meeting the print tone reproduction requirements does not necessarily imply that the resulting print will be technically pleasing. In practice the print will usually be satisfactory if the subject brightness was not high, but with a subject of high contrast the result will often appear flat, even though both tonal requirements have been met. This is because the brightness range of a high contrast subject is greater than the maximum range that can be obtained on a paper. Two remedies are possible. The simplest is to print the negative with a higher number printing filter and to sacrifice detail in either the shadow or highlight areas of the subject. This, in effect, means abandoning one of the tone requirements. The preferred remedy is to use a higher number printing filter but to isolate the various tones within the picture, and treat them individually by printing in or dodging. In this way, you can get the contrast you desire without sacrificing shadow or highlight detail.

PRINTING FILTER SELECTION.—The exposure scale of a paper indicates the differences in light intensity necessary to produce the full range of tones of which the paper is capable. If a light intensity of one unit produces a barely visible image and a light intensity of 30 produces the maximum black, the exposure scale is 30 to 1. For different surfaces of the same paper type, the exposure scales are essentially the same.




To determine the proper variable contrast printing filter to use:

1. Read the density in the negative of the blackest highlight in which *some detail* in the print is expected.
2. Read the shadow density, or lightest part of the negative where detail is required.
3. Subtract the shadow density from the highlight density; the difference is the density range of the negative. For example:

| | | |
|---|---|---|
| Highlight density | = | 1.62 |
| Shadow density | = | 0.32 |
| Density range | = | 1.30 |

4. Match the density range of the negative to the printing filter.

Of course, the printing filter required for each density range may vary from lab to lab and within a lab, depending on the type of equipment used, the process applied, and other variable factors. The table below showing variable contrast filters suitable for printing various negative density ranges is for the purpose of example *only* and should not be interpreted as necessarily a standard. Each processing lab will have to determine its own suitable filters for various negative density ranges.

| PRINTING FILTER NUMBER | NEGATIVE DENSITY RANGE |
|---|---|
| 1 | 1.21 or above |
| 1 1/2 | 1.06 to 1.20 |
| 2 | 0.86 to 1.05 |
| 2 1/2 | 0.71 to 0.85 |
| 3 | 0.60 to 0.70 |
| 3 1/2 | 0.49 to 0.59 |
| 4 | 0.48 or below |

## COLOR

As color film for aerial reconnaissance photography comes into wider use, the need for rapid processing becomes necessary. This need is being met by the installation of modern rapid color film processing machines in the CVICs. These color processing machines are basically the same as black and white processors, however, the chemistry involved is highly specialized. And, for this reason, the requirements for strict adherence to the quality assurance procedures set up by manufacturers for their various processes must be maintained.

Since each manufacturer of color film has specified methods for processing specific film, different films and developers can't usually be interchanged.

### Color Quality Assurance

Processing color reconnaissance films requires strict adherence to established QA procedures. Control strips representing the various color recon films are available from the film manufacturer and should be used to monitor the color process.

Inherent control of the quality of color is a basic responsibility of the manufacturer. The specified end product of the system used can only be obtained by strict adherence to the process specifications which will give a good usable result. Control limits by necessity are very close, owing to the nature of color materials. With the installation of automatic color processing machines aboard carriers and at many shore stations, the need for color quality assurance is essential, and must be accomplished by using the directions supplied by the manufacturer.

## POST-MISSION MAINTENANCE EVALUATION

Photographer's Mates working in the CVIC must be able to supply accurate maintenance feedback information to the reconnaissance system maintenance crews. As the end results are a true measure of the system performance, this feedback will:

- Ensure that maintenance personnel are aware of possible system malfunctions.
- Aid in evaluating the overall system performance.

## SERIAL FRAME AND PANORAMIC CAMERA FILM EVALUATION AND ANALYSIS

The process of evaluating the photographic negative to determine system defects, as related to overall performance, can be considered to be one of the most complete measures of the system's output. System defects noted during film evaluation should be recorded on a film maintenance feedback form and forwarded to maintenance for action in areas of system or component malfunctions.

### Frame Spacing

On all serial frame and panoramic camera imagery, there should be a space between each exposed film frame. While the space may differ in width, due to cameras or design requirements, it should be there. Frame spacing defects will generally indicate a system defect; e.g., failure in the film advance mechanism.

### Image Overlap

Image overlap between successive frames provides a stereo viewing capability and relatively distortion-free imagery to make a mosaic.

Tables provided with various aerial cameras give overlap specifications for serial frame and panoramic cameras. In the event that the overlap is not met, it is probable that the camera is receiving an improper V/H (velocity/altitude above ground level) signal from the system. In addition to not fulfilling the intended purposes of acquiring overlap, this problem can cause blurred images.

### Data Block

Each frame of a modern serial frame or pan camera contains a data block and other pertinent information about the mission such as film and flight direction, frame count, etc. In an infrared reconnaissance set (IRRS), the data block is

# MAINTENANCE FEEDBACK FORM

(TO BE COMPLETED BY EVALUATOR AND ATTACHED TO COMPLETED MISSION PLANNING FORM)

SORTIE #_____ FILM EVALUATOR (NAME)_____

SORTIE DATE_____ EVALUATION DATE/TIME_____

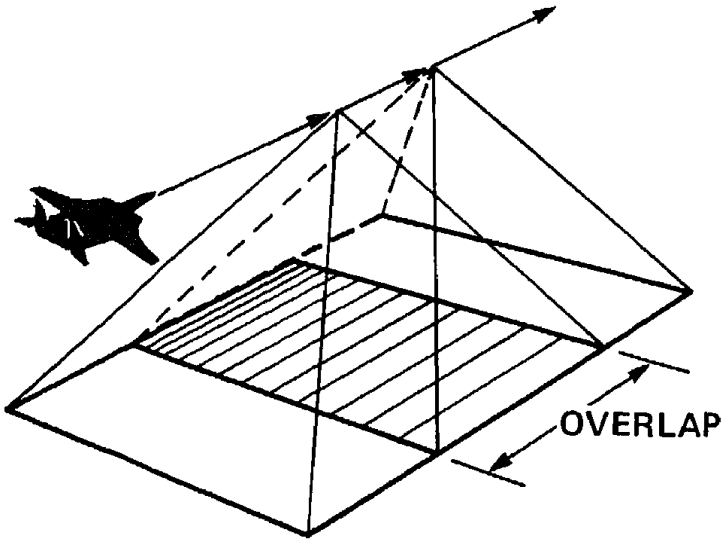
MAINT WORKCENTER REVIEWER (INITIALS)_____

| | SENSOR | MEASURED RESOLUTION | FILM INTERPRETABILITY | DISCREPANCIES OBSERVED | JCN |
|---|---|---|---|---|---|
| STATION 1 | | | | | |
| STATION 2 | | | | | |
| STATION 3 | | | | | |

# FILM MAINTENANCE FEEDBACK

DATE _____

| JCN | | DISCREPANCY | | COMMENTS |
|---|---|---|---|---|
| | A | SCRATCHES: BASE | 1 2 3 | |
| | B | EMULSION | 1 2 3 | |
| | C | LINES/MARKS: VERTICAL | 1 2 3 | |
| | D | HORIZONTAL | 1 2 3 | |
| | E | TEARS BASE | 1 2 3 | |
| | F | EMULSION | 1 2 3 | |
| | G | FOLDS/CREASES | 1 2 3 | |
| | H | RESIDUE | 1 2 3 | |
| | I | WET/TACKY | 1 2 3 | |
| | J | SPOTS | 1 2 3 | |
| | K | LIGHT EXPOSURE: STEAKS | 1 2 3 | |
| | L | DISPERSED (FOG) | 1 2 3 | |
| | M | IMAGE: EXPOSED | 1 3 3 | |
| | N | BLURRING/FOCUS | 1 2 3 | |
| | O | BLEEDING/FUZZY | 1 2 3 | |
| | P | VIGNETTING | 1 2 3 | |
| | Q | FORMAT: OVERLAPPING (%) | 1 2 3 | |
| | R | FRAME SPACING | 1 2 3 | |
| | S | NUMBERING | 1 2 3 | |
| | T | FIDUCIAL MARKS | 1 2 3 | |
| | U | CMB: EXPOSURE | 1 2 3 | |
| | V | INCORRECT | 1 2 3 | |
| | W | INCOMPLETE | 1 2 3 | |
| | X | FOCUS | 1 2 3 | |
| | Y | SKEW | 1 2 3 | |
| | Z | | 1 2 3 | |
| | | DENSITY | 1 2 3 | |
| | | SHARPNESS | 1 2 3 | |
| | | USEFUL | 1 2 3 | |




**Line-of-flight forward overlap.**

usually recorded periodically along the length of film. Discrepancies in the image of the data block are usually caused by a malfunction within the sensor (camera or IRRS).

### Static

When a material (film) by some means loses or gains electrons (negatively charged particles), it becomes either positively or negatively charged. Such a charged material seeks to return to a neutral state by transfer of electrons from or to other objects, air, or ground—sometimes without event, and sometimes with disruptive force accompanied by heat and light. This light fogs unprocessed film emulsions and causes markings when the film is developed.

### Shutter Banding

Banding associated with focal plane shutters is caused by defective shutter operation and is easily interpreted by the presence of uneven illumination streaks across the line of flight. This defect is caused by the focal plane shutter slit varying in dimension and/or erratic shutter curtain travel during the exposure cycle.

Banding in the pan camera is caused by exposure slit variations and erratic film transport through the focal plane.

### Camera Light Leak

Camera light leaks are often difficult to recognize. They can cause various nonimage-forming shapes and will appear and disappear as the angle of light to the leak changes. The light leak will cause areas of the film to be fogged.

### Exposure

A negative which has detail in both the shadow and highlight areas is said to be properly exposed. However, when evaluating the negative image, it is necessary to consider the subject matter because less exposure is required for light sandy beaches and snow-covered terrain and more exposure is required for dark terrain such as forests, industrial sites, etc.

When you are viewing a negative that has been exposed normally, patches of snow or light beach scenes will appear overexposed. Inversely, patches of dark terrain or industrial sites will appear underexposed. If the negative is completely underexposed or overexposed, then the camera's film sensitivity/filter factor (S/C) setting was incorrectly chosen or the camera automatic exposure control (AEC) system malfunctioned.

### Processing

Film development is an important part of image acquisition and as such deserves consideration. Film is normally processed to a gamma specified by the reconnaissance coordinator. The gamma value is selected to achieve a density of 0.70 for the anticipated average scene brightness. If the scene brightness is of a contrasting nature, the processing gamma will be lower than normal. If the scene brightness is "flat" (of low contrast), the processing gamma will be higher than normal. The scene tables provide the brightness information needed for computing gamma and S/C setting for variations in scene brightness.

### Vacuum

A lack of adequate vacuum in a serial frame camera will allow the film to sag away from the focal plane, causing the image to be blurred. One indication of loss of vacuum or insufficient vacuum can be seen as crooked data blocks.

**Miscellaneous Defects**

Reflections from the aircraft camera window, depending on the angle of the sun in relation to the window, can cause nonimage-forming exposure of the film.

Condensation on a camera lens can result in a halo effect surrounding film image points and is generally caused by a rapid aircraft descent immediately before a photo run.

## INFRARED RECONNAISSANCE SET (IRRS) FILM EVALUATION AND ANALYSIS

Careful evaluation of IRRS film is required to determine that overall system performance is adequate. Film evaluation can confirm malfunctions observed by the flight crew and provide more specific information as to the cause of the problem. Also, many discrepancies can be observed on the film which would not be shown by the system indicators in the aircraft.

### Infrared (IR) Evaluation Checks

Using a light table and a 10-power or greater magnifying glass or loop, you normally check the IR film for the following presentation characteristics:

Imagery width

Code matrix block

Fiducial mark

Special interest mark

Hot target mode operation

Focus

Geometric accuracy

Drift compensation

The IR imagery is also checked for the absence of the following image degrading characteristics:

Fine sync jitter

Fine sync breaks

Coarse sync breaks

Double imagery

Roll error

Drift error

Extraneous noise

Static

*Additional information regarding degraded imagery is contained in technical manuals for the various sensors and reconnaissance systems.*

# CHAPTER 4

# SPECIALIZED PHOTOGRAPHY

In this chapter we will discuss some of the aspects of what we call "specialized photography." We refer to it as specialized photography only because it is not the type of photography most of our photographers do on a day-to-day basis. Our intent is not to make you an expert in the types of photography presented, but to give you a basic understanding of the different types of "unusual" photography you may be faced with from time to time.

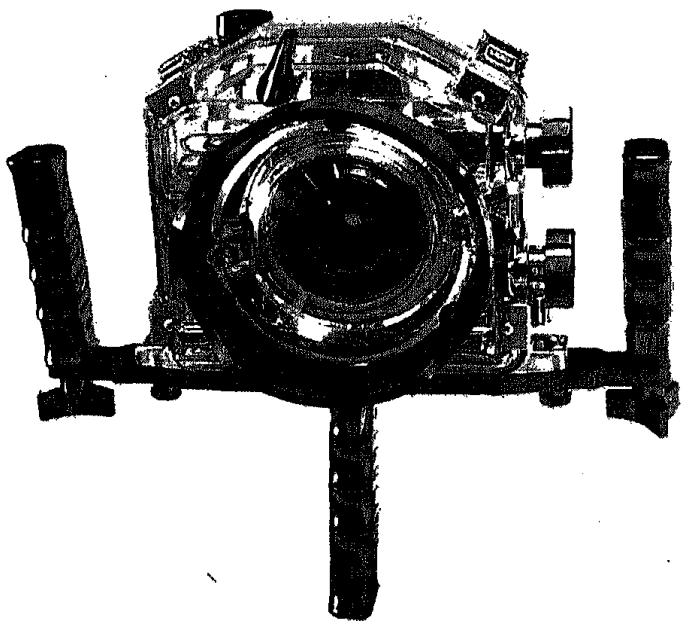
As a senior PH, you may be required to perform, supervise, or teach these specialized photography techniques to photographic and nonphotographic personnel. For example, *all* underwater photography in our Navy is done ONLY by qualified divers. Since few PHs are qualified divers, most underwater photography is performed by sailors in other rates. In the case of underwater photography, you may be called on to provide theoretical knowledge of the subject rather than a practical knowledge. When a diver has problems obtaining high quality underwater photography, his first inquiry will probably be to a senior PH. As such you should be able to tell the diver how to produce high-quality, professional, underwater photography.

## UNDERWATER PHOTOGRAPHY

The Navy has always had a need for underwater (UW) photography. Aside from its usefulness in military and salvage operations, UW photography is a valuable tool to the marine biologist and to many other types of scientists and engineers. For example, when the hull of a ship is damaged below the waterline, the only way engineers and damage control personnel may be able to assess the damage is through photographs. A photograph permits an unhurried examination or a precise, critical analysis by the specialist. A photograph made underwater may show a wealth of detail unnoticed by the diver at the time the picture was made.

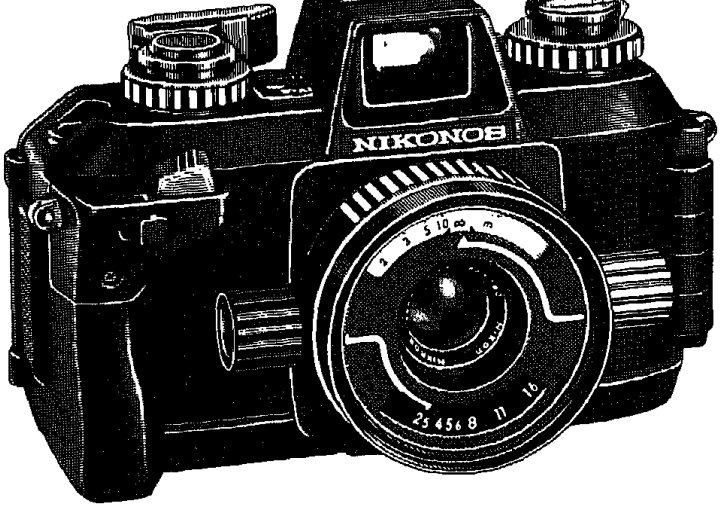
## UNDERWATER PHOTOGRAPHIC EQUIPMENT

Most photographic equipment can be used underwater if it is adequately protected. Photographic equipment for use underwater should be quite rugged because it will be subjected to seawater and hard bumps. Protective, watertight housings are available for most types of photographic equipment. These housings are usually made from polyethylene plastics, cast and extruded aluminum, and stainless steel. In-air or regular ground-type handheld cameras and accessories such as exposure meters and electronic



*Courtesy ikelite Underwater Systems.*

**35mm SLR underwater camera housing.**




*Courtesy Nikon, Inc.*

**35mm self-contained underwater camera.**

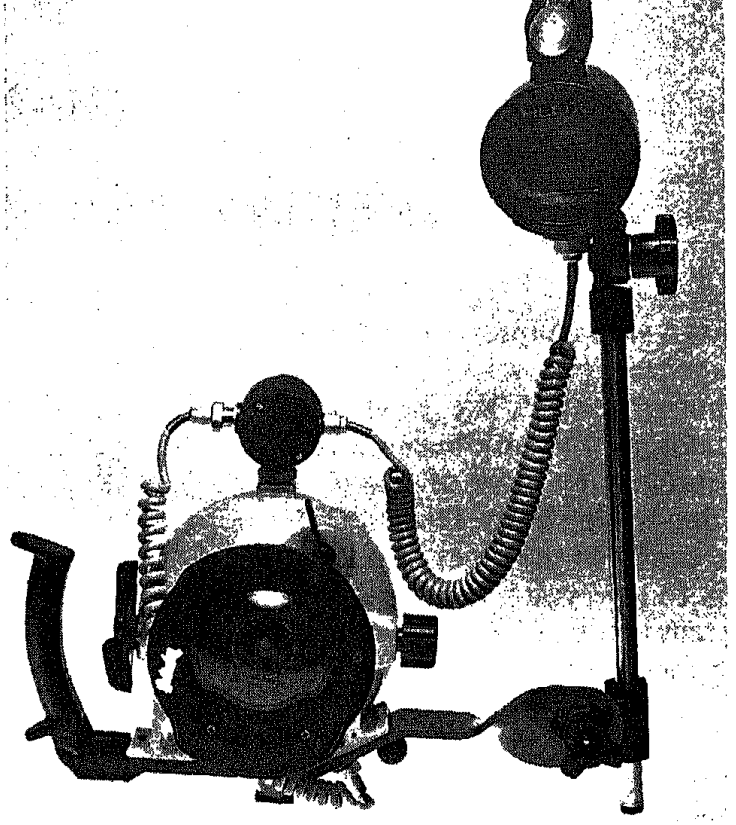
flash units can be placed into these watertight housings for use underwater. An extensive line of special "underwater" equipment is also available. With these "self-contained" cameras and accessories, the outer shell or body of the device protects the inner workings from the water. This type of equipment is more compact than a camera or accessory housing and is less buoyant and, therefore, easier to handle underwater.

## Camera Housings

The primary purpose of an underwater camera housing is, of course, to protect the camera from water. Most commercial camera (and accessory) housings do that. The housing should be designed so that the camera's normal in-air functions are limited as little as possible. That is to say, advancing the film, tripping the shutter, and changing shutter speeds and f/stops should be as easy to do underwater as it is in air.

LENS PORTS.—Most underwater camera housings have one of two main types of lens ports—either *flat* or *dome*. The lens port is the part of the housing through which the camera lens "sees."

Flat Lens Ports.—Flat lens ports have been used in camera housings ever since cameras were used underwater. A flat lens port is made of glass or optical plastic and is, as its name implies, flat.



*Courtesy Helix Limited.*

**35mm SLR underwater camera housing with electronic flash.**

A disadvantage of flat lens ports is image distortion which occurs because of the refraction of light, especially when wide-angle lenses are used. Refraction, remember, is the bending of light rays as they pass from one transparent medium to another. This refraction occurs when the light rays enter a medium at an angle other than perpendicular to its surface. This bending or refraction of light caused by a flat lens port results in the following underwater problems:

- Subjects appear closer and, therefore, larger than they actually are. From the observer's point of view they appear to be about three-quarters of the distance they actually are.

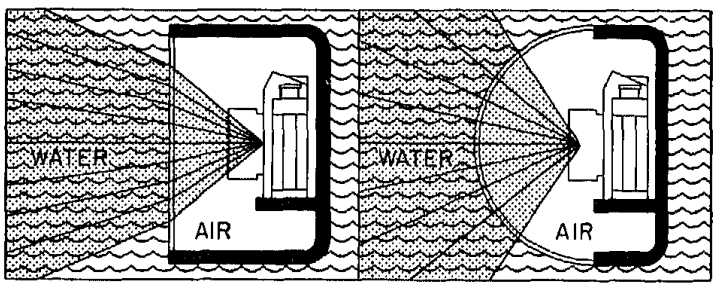
- When used behind a flat lens port, the angle of coverage of a lens changes and will be about three-quarters of its angle of coverage in air.

- Distortion can be excessive around the edges of a picture made through a flat lens port. Blurring and chromatic aberration or color shifts

lenses are used.

Dome Lens Ports.—Dome or corrected lens ports, as they are called, eliminate the distortion associated with flat lens ports. This is because, *theoretically*, all light entering the dome is at 90 degrees or normal (perpendicular) to the surface of the dome, and no refraction occurs.

Dome lens ports allow the use of wide-angle lenses while preserving image sharpness and color accuracy. However, dome lens ports act as lenses underwater and produce a virtual (not real) image. The virtual or apparent image is closer to the camera than the actual object therefore focusing should be done visually and not by consulting the distance scale on the camera lens.




FLAT PORT DOME PORT

**Lenses**

Experience has shown that it is impractical to use normal or long focal length lenses underwater. There are two primary reasons for this: first, water is many, many times less transparent than air, and good contrast can only be obtained by getting as close as possible to the subject being photographed; second, all objects underwater appear closer to the observer by about one-third the actual distance. (This is caused by the refraction of light.) Lens focal lengths are consequently "stretched" to the same proportion; i.e., a 35mm focal length lens becomes a 47mm lens; a 28mm becomes a 37mm, etc. Some other reasons for using short focal length lenses for UW photography are:

● *It is usually impractical to set or change the lens focus distance underwater.* Even when the camera is housed in a watertight housing which allows the lens focus distance to be changed underwater, the diver usually finds it of little use since both he and the subject may be in continuous motion relative to each other. For this reason the depth of field should be as great as possible. The only practical way to achieve this underwater is to use short focal length lenses. It is not feasible to use a smaller f/stop to increase depth of field because that would require more light than is usually available underwater—even with artificial light sources.

● *The lens angle of view should be as wide as possible.* This is because of the need to get close to the subject yet still include a point of reference (in order to make clear the real position of the subject) such as the ocean bottom when making pictures of another diver or a fish, etc.

● *It is best to have the smallest possible amount of "water thickness" between the camera and the subject.* Even what appears to be very transparent water may affect the available or artificial light to such an extent that a distance of 2 feet could make the difference in a good picture and no picture at all. Besides the scattering of light by water, light absorption also makes it necessary to get as close as possible to the subject to get high-quality photographs.

**UW Equipment Maintenance**

All photographic equipment used underwater needs special care, especially if it is used in saltwater. In ocean UW photography, salt buildup can cause corrosion and leaks. Since most of the screws and bolts used to build underwater photographic equipment are stainless steel or brass and the housing or outer cases may themselves be made of aluminum, corroding caused by electrolytic action where the salt interacts with the dissimilar metals is likely to result unless the equipment is thoroughly cleaned after each dive.

FLUSHING EQUIPMENT.—After a dive, all photographic equipment used underwater must be thoroughly cleaned. It is not enough to simply rinse the equipment under fresh running water for a minute or so. Instead, soak the equipment completely submerged in fresh clean water

rinsed, in fresh, clean running water. When the equipment is flushed, any areas where saltwater could accumulate, such as around the controls, and in flash sockets, etc., must be given special attention.

After the equipment has been thoroughy rinsed it should be air dried or blotted with a soft towel. Don't use hot air to dry equipment and never leave it in the sun to dry. The lens ports should always be blotted dry with lens cleaning tissue to prevent the formation of water spots. After the equipment is dry, housings can be opened or components separated and the film removed.

CARE OF O-RINGS.—After the equipment has been dried and opened, the O-ring and O-ring

- A light coating of O-ring grease should be used on O-rings. Excess grease should be removed. Only recommended silicone grease should be used.

- Grit and sand should be cleaned off of O-rings and from O-ring grooves to prevent water leaks.

- Equipment housings should be assembled carefully to prevent the distortion or pinching of O-rings.

- O-rings should be changed at least annually.

**(1) Completely submerge the equipment in clean fresh water.**

**(2) After submerging the equipment for several minutes, rinse with fresh running water.**

FLOODED EQUIPMENT.—If an underwater camera housing, other equipment, or an underwater camera becomes flooded, immediate steps should be taken to try to salvage the equipment. If the camera or other equipment floods, take the following steps:

- Remove the film and batteries. If an electronic flash unit floods, allow it to discharge, then turn it off, open it and let the water drain out, then carefully remove the batteries.

- Remove all the O-rings and place the flooded item into clean fresh water as soon as possible.

*Seawater begins its corrosive action very quickly.*

The flooded item should be immersed for at least half an hour. While the item is submerged, operate the controls—switches, levers, gears, shutter, film advance and rewind, lens focus distance, etc. The objective is to replace all the saltwater with freshwater.

- After flushing in freshwater, low-pressure air should be used to remove as much water as possible.

- After most of the water is removed with low-pressure air, the equipment may be soaked in alcohol. Again operate the various controls for about 30 minutes while the item is immersed in the alcohol. When the equipment is removed from the alcohol bath, the alcohol, which absorbs water, will quickly evaporate.

- Low-pressure air is used to help drive out any remaining moisture and to help the alcohol evaporate.

- If a competent camera repairman is available he should then repair the equipment. If a repairman is not available, the equipment should be packaged with desiccant and sent by the fastest

## LIGHT AND UNDERWATER PHOTOGRAPHY

Available light underwater, also called ambient or natural light, is that light from the sun or sky that strikes and penetrates the surface of the water. This available light, as well as artificial light, behaves in several ways that an underwater photographer should be aware of in order to make good UW photographs.

### Reflection

Some of the sunlight striking the water's surface is reflected into the air by the surface of the water. The rest penetrates the surface. The best light penetration occurs when the sun is high in the sky—around noon. The lower the sun, such as during early morning or late afternoon, the more light is reflected into the sky and less light reaches underwater. Therefore, the best time of day for UW photography by available light is around noon or between about 1000 to 1400.

The amount of light reflected by the water's surface and thus the amount of light reaching underwater is also dependent on the condition of the surface of the water. When the sea is calm, relatively little light is reflected; however, when the sea is rough or choppy, the many small surfaces of the waves reflect much more light into the sky and subsequently less light penetrates the water's surface. Hence, the least amount of light will be lost to reflection on bright, calm days between about 1000 to 1400.

### Refraction

That light which does penetrate the water's surface undergoes a change in direction. That is to say, the light is refracted. The least amount of refraction occurs when the sun is directly overhead. Refraction increases as the sun approaches the horizon. When the sun is low in the sky, the light rays have to travel a greater

of the light.

The best time of day then, for available light UW photography, is when refraction is least. This again is from about 1000 to 1400.

### Scattering

When light rays strike very small particles, such as minute organisms in water, the particles will absorb some light and reflect and scatter the rest. Thus light passing through water containing floating debris is scattered and diffused as it travels. This diffusion or scattering produces a haze or veil which limits the visual or photographic underwater range. The maximum distance at which an object may be clearly seen or photographed underwater depends on the amount of light that is scattered by the substances in the water and the scattering effect of the water itself. That part of the scattered light which the observer sees reflected from an underwater object appears as an overall haze and lowers the apparent contrast between the object and the surroundings. As the distance to the object is increased, the object fades more and more into the haze and is eventually lost to view. In true oceanic waters (offshore), the transparency of the water is relatively high and the scattering is relatively slight. In even the clearest coastal waters, scattering is a result of suspended matter in the water. Both absorption and scattering can give rise to color effects in bodies of water. Filters may help to provide color correction or contrast, but they offer little in minimizing the effects of cloudy water or scattering.

Seawaters are normally clearest during the cold months when microscopic plant life and animal life in the water are at a minimum.

### Absorption

As light penetrates to greater depths beneath the water's surface, it is rapidly absorbed by the water. When available light color photography is done underwater, one of the first things noticed is that the pictures have an overall blue or green

some of the colors that make up white light. The first foot of water may absorb or filter out up to about 60 percent of the infrared portion of the electromatic spectrum but very little of the visible light.

In pure clean seawater, about 55 percent of the surface visible light intensity remains 25 feet down, while in turbid or muddy water (depending on the degree of turbidity or muddiness), the light is even less as depth is increased. Even in "clear" water most of the red wavelengths of light are absorbed by the time the light reaches a depth of just a few feet. Only the blue and green components of white light penetrate water to any great depth.

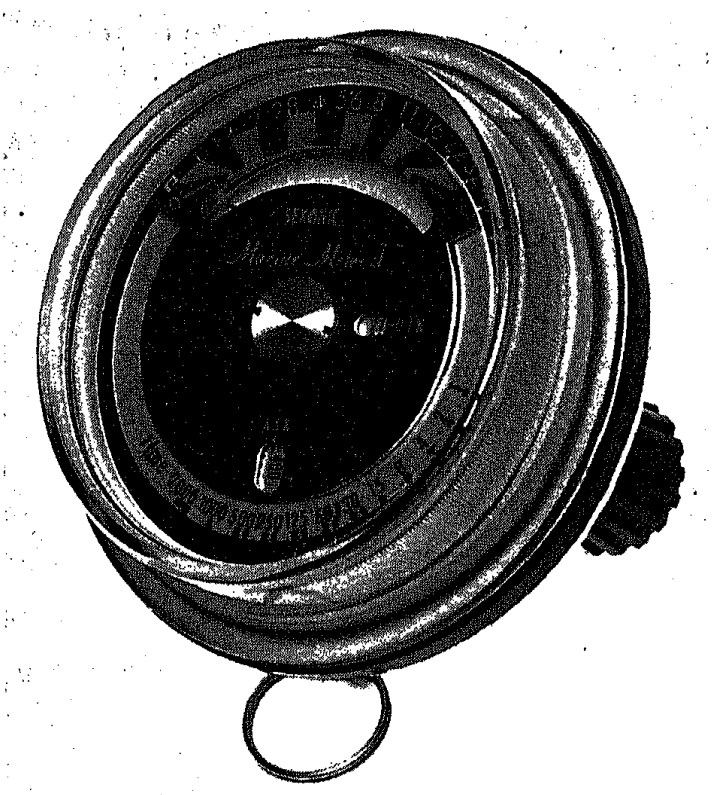
Not only will the depth at which the photographer is working affect the intensity or color of the available light, but the distance from which the subject is photographed will also have an effect on color and intensity.

Remembering that turbid or muddy water affects the amount of light reaching a subject, these same conditions also affect the amount of light reflected from the subject to the camera. Thus, camera-to-subject distance must be taken into consideration on all underwater exposures.

To reproduce all the colors that are present, color underwater photography should be done close to the surface or artificial lighting should be used and the lens-to-subject distance kept to a minimum.

## UNDERWATER EXPOSURE WITH AVAILABLE LIGHT

An underwater photographer works in a complex and changeable medium under difficult conditions of cold, violent swaying of both the photographer and the equipment, and the encumbrance of diving equipment. There are various conditions which arise in underwater photography which are not present on the surface, making the calculation of exposure difficult.



*Courtesy Helix Limited.*

**Underwater exposure meter.**

Underwater photography by natural light should be undertaken between midmorning and midafternoon. The best lighting conditions, as we said, are from about 1000 to about 1400, since the amount of light available underwater decreases as the sun gets lower in the sky. Illumination intensity underwater also depends upon reflection from nearby objects; for example, the light level is greater over a sandy ocean bottom than it is over seaweed or mud.

## Exposure Calculation

Calculating how much light is present in any given scene on the ground is hard enough; underwater it is even more difficult. For surface photography on a clear bright day, exposures can be calculated by using the f/16 rule. Underwater, the f/16 rule is unreliable because of the adjustments that must be made for depth and all the other factors that reduce the intensity of light.

EXPOSURE METERS.—The best method for calculating underwater exposure is with an exposure meter—an absolute essential in underwater photography.

The mere loss of gross intensity due to absorption and scattering is not the only factor to be considered in calculating underwater exposure. For one thing, light of different colors is absorbed at different depths in seawater. For example, at only a few feet below the surface, red light is almost completely absorbed. Yellow light starts being absorbed at about 40 feet, until only green light and blue light remain at about 60 feet.

Most exposure meters read light intensity without regard to color balance. Because the spectral character of light underwater will be different from that on the surface, taking exposure meter readings and calculating filter factors can be a problem. Factors other than light characteristics are encountered by the photographer from the moment he enters the water. His stability and mental capacities are impaired by the unnatural environment, and the impairment becomes greater the deeper he descends.

Underwater there may be only blue-green light, an abnormal color mixture for a meter calibrated for average daylight. For panchromatic film, the reading under such conditions may be all right, provided the meter is designed to read all visible light with roughly the same response as the film. It is well to remember that errors can occur in exposure meter readings due to this abnormal spectral distribution. Therefore, if possible, the best method is to make a series of test exposures shot at a range of f/stops around the meter reading. Experience with the meter should soon show how its readings are to be corrected for normal underwater photography.

## Filters

The diffused light conditions underwater caused by scattering reduce the color contrast and "blur" the edges of objects viewed at a distance. This blurring or haze in distant photographs in

clear water is caused mostly by scattering of the blue light. One method used in black and white photography to reduce the effects of this blur or haze and gain contrast is to use a minus blue filter such as a Wratten number 12. However, the filter cuts down the amount of light reaching the film. Another method of increasing the contrast is by overdeveloping the film.

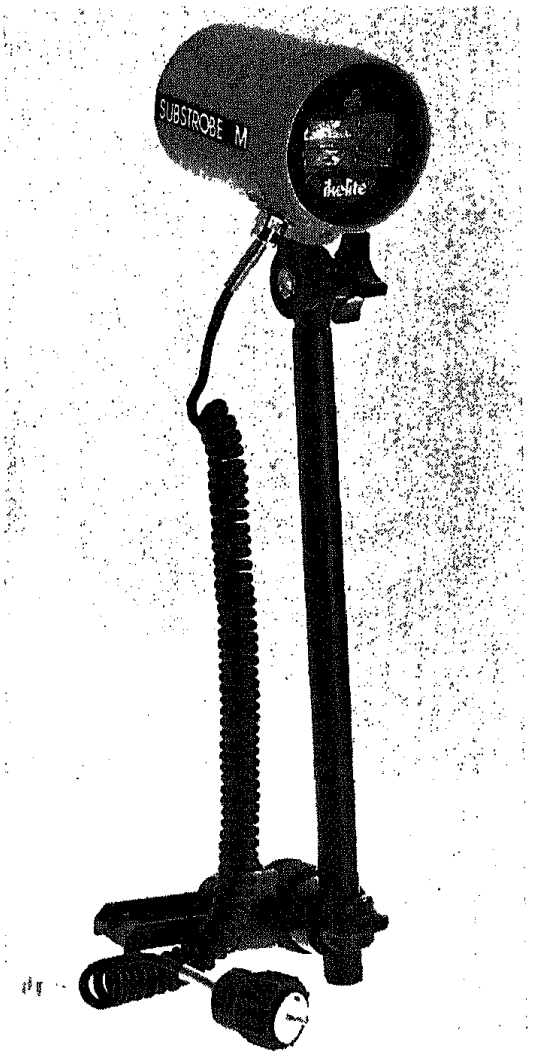
Because of the difference in color balance underwater from that on the surface, figuring a filter factor is somewhat complicated. The published filter factor for a specific filter is generally not the one which should be used when the filter is used underwater. For example, a Wratten number 12 filter, which transmits in the red-yellow region and has a filter factor of 2 in white light, would produce a very underexposed UW negative when the filter factor of 2 is applied to UW exposures. The meter is reading gross light intensity, most of which will be in the blue region, which the number 12 filter does not transmit. The actual filter factor might be as high as 10 or more. The only suitable way to arrive at the correct exposure with such a blue-green blocking filter is to take an exposure meter reading through the filter.

### Black and White Film

Any type of fast panchromatic, B&W long-scale film may be used in underwater photography. The speed of the film selected depends upon the light conditions.

### Color Film

Fast daylight-type color film, either negative or positive, may be used for underwater photography. As explained earlier, due to the filtering action of the water, the predominant light underwater is blue-green. This predominance of blue-green light is less noticeable to the underwater photographer, whose eyes automatically adjust to the prevailing light conditions, than it is to color film which is balanced for light of a certain color temperature. The use of red color correction filters is of doubtful value since they can only be used where red and orange light has not completely disappeared from the water. In addition, the use of a filter calls for a larger lens opening which decreases depth of field.




*Courtesy ikelite Underwater Systems.*

**Underwater electronic flash unit.**

## UNDERWATER EXPOSURE WITH ARTIFICIAL LIGHT

Artificial light or an electronic flash is very helpful in providing sufficient light and color balance in underwater photography. By using artificial light, the underwater photographer has the ability to place the light source at any desired position, within limits.

*Courtesy Helix Limited.*

**Handholding the electronic flash to avoid back-scatter.**

New problems are involved in using an electronic flash underwater. The guide numbers used on the surface must be modified to compensate for the light lost by absorption underwater. Alternate guide numbers and exposure suggestions provided by equipment manufacturers can only provide a starting point from which to conduct exposure tests.

The light from an electronic flash is about 5600°K. This color temperature is usually too "blue" for color photography underwater. This condition can be corrected by placing a CC filter inside the flash housing; e.g., a 20 to 50 red, depending on the depth and flash-to-subject distance.

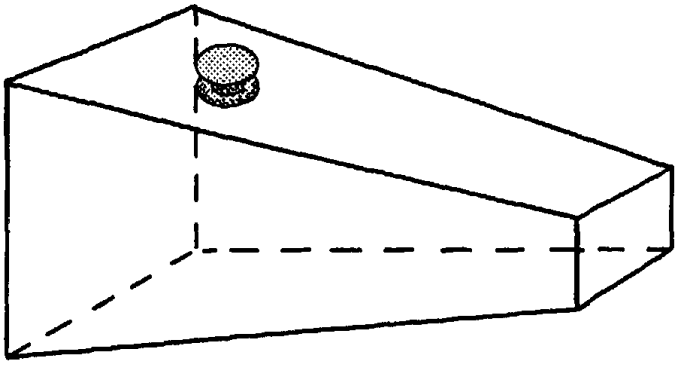
## Backscatter

Backscatter is one of the most frequent problems encountered in UW flash photography. By understanding what backscatter is, a subsurface photographer will be able to produce better UW pictures because he will be better able to control or eliminate backscatter.

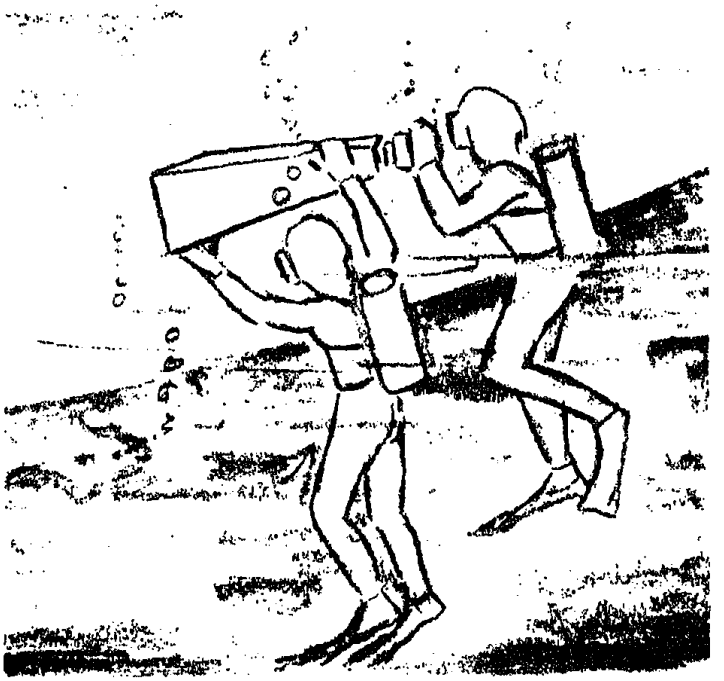
Most water isn't really clear. It contains suspended particles such as plankton or minerals. This suspended matter acts like millions of tiny reflectors that reflect light that is directed at them from an electronic flash. When your car headlights are used at night in a snowstorm, you have a good example of backscatter.

Backscatter can be greatly reduced by keeping the flash off the camera. Generally speaking, if the flash is held about 20 inches away from the camera and at an angle of about 45 degrees to the subject, backscatter is minimal. Lighting an UW subject from above and from an angle of about 45 degrees also creates a more natural appearance. Backscatter also is less if the bottom sediment in the area is not disturbed.

When making closeup UW photographs of hull or screw damage to a ship, for example, if the visibility underwater is very limited due to sediment or dirty water, then the resulting photographs will probably be of poor quality. A way to overcome this "visibility problem" for the camera is to construct and use a *clear-water chamber* to make the exposures through.



A clear-water chamber is simply a truncated-pyramid shaped plexiglas "box." The clear-water chamber is filled with fresh clean water which gives the chamber equilibrium underwater. The chamber is held underwater by the photographer's diving partner, with the large flat end very close to the subject. The photographer holds the camera against the small flat end to make the exposure.



By using the clear-water chamber, the dirty water which would have been between the camera and subject, and would have obscured picture detail, is displaced by the chamber, and the distance between the camera and subject is occupied by clear water which provides much better camera visibility and results in much better photographs.

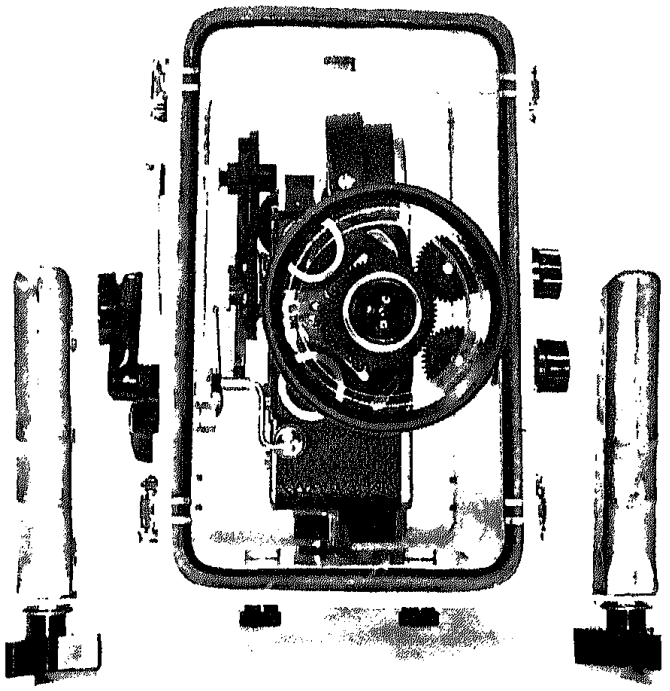
## COLD-WEATHER PHOTOGRAPHY

The Navy has long been involved in the exploration of the Antarctica continent and Navy photographers have been fully involved in all Navy expeditions to this cold weather region. Navy photographer's duties may take them to many areas of the world where the weather is cold. Ships of our Navy operate in the oceans of both the extreme north and south latitudes. Even our shipmates assigned to shore stations may find themselves involved in cold weather photography—for example, those photographers stationed at NAS Brunswick, Maine, in the winter will certainly be doing some cold weather photography.

Our discussion here will center around those temperature, weather, and light conditions in the northern and southern polar regions which require the use of special photographic techniques and specially prepared equipment or supplies. These techniques and equipment are also recommended for use in other regions where and when temperatures of 30 °F and below are encountered.

## COLD-WEATHER CONDITIONS

The temperature in polar regions in the winter months may range from about −10 °F to −128 °F or lower, and in summer, from below freezing to about 50 °F.



*Courtesy ikelite Underwater Systems.*

**A motion picture camera in an underwater camera housing.**

There is little rainfall in these polar regions, and precipitation in any month of the year usually is snow. Cold temperatures are usually accompanied by low relative humidity. Because of the low relative humidity, the atmosphere in polar regions is exceptionally clear, making it possible to see farther than in temperate climates. This makes it difficult for the photographer to judge accurately the size and distance of objects, especially where there are no familiar adjacent objects to serve as guides or comparisons. This phenomenon can be very noticeable in the pictures you make outdoors in these regions.

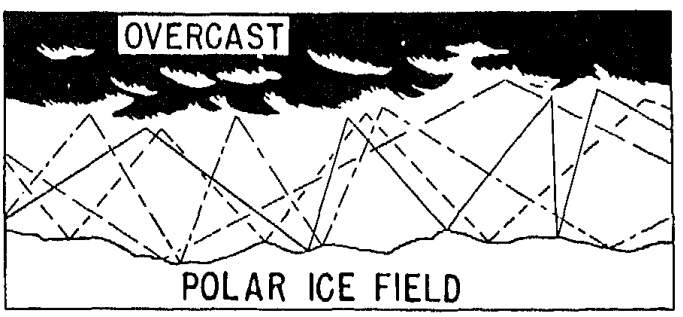
Strong polar winds occur in all seasons. A distinctive feature of these polar winds is their extreme cooling effect. Although temperatures may be comparatively mild, high winds create a wind and temperature combination known as wind chill or a chill factor. As a rule of thumb, the wind chill index is the actual temperature minus one degree per knot of wind. For example, a temperature of $-30°F$ with 10 knots of wind is equal to about $-40°F$. The effect of wind chill can make your job as a cold weather photographer very difficult.

High surface winds blow loose snow around, detail, thus limiting the effectiveness of your photography. Blowing snow also blows into any openings in your equipment and causes operating problems, especially if the snow is not removed before the equipment is allowed to warm up. If the snow is left on your photo equipment when the gear is brought inside, it melts and causes rust and corrosion. If the water remains in the equipment and the equipment is again used outdoors in the extreme cold, the water will freeze and cause severe damage to the equipment.

## Whiteouts

Whiteouts frequently occur over polar ice or snow whenever there is an overcast. On these days it is impossible to distinguish surface irregularities regardless of their conformation, unless there is a discoloration of some sort present. Whiteouts are most disappointing to a photographer, because it is virtually impossible to expose correctly for other than nearby colored objects. There are no shadows, and white will not photograph well. Exposures of persons or objects which absorb any degree of light will produce an image on the negative, but the photographic results create the illusion that either the images are hanging in space or that the background and foreground print images have been bleached out. Because of the lack of shadows, it is very difficult to distinguish the surface. The texture of the ice and snow surface cannot be seen until there is undiffused sunlight to cause surface irregularities to cast shadows.

As a polar photographer you may experience confusion and problems when it becomes necessary for you to photograph during a whiteout. The usual problem of getting adequate



photography is not present during whiteouts, since there are no shadows. The omnidirectional diffused light results in a short scene brightness range. Overexposure should be avoided as well as underdevelopment of the film.

Another unusual feature of whiteouts is the great amount of light present. Light penetrates the overcast and strikes the white surface where it is almost entirely reflected to the overcast. The light is then re-reflected by the overcast to the snow surface, then to the overcast again, etc., etc., with a resultant buildup of light intensity.

## EQUIPMENT

All photographic and audiovisual equipment that is going to be used extensively for cold weather photography should be winterized or cold-conditioned. This treatment is advisable to:

- Eliminate undue drag on moving parts caused by congealment of lubricants.
- Minimize malfunctioning due to contraction and other cold weather reactions of materials.
- Preserve the quality of the equipment.
- Obtain a greater degree of efficiency from its operation in cold temperatures.

Many cameras and other photographic equipment designed for operation in normal temperatures will operate effectively in very cold temperatures, without special winterization treatment, when taken from a warm place into the cold for a short time and then returned promptly to warmth. One way of doing this, with smaller cameras, is to keep the camera, when not in use, under your coat and close to your body to keep it warm. Then take the camera out to make your pictures and as soon as you can, put it back under your coat and next to your warm body. For the best results, however, the equipment should be winterized.

### Winterization

Winterized photographic equipment is gear which has been conditioned to operate satisfactorily at temperatures as low as about $-65\,°F$.

- Complete removal of all lubrication, and relubricating with special cold-weather lubricants, if any.
- Special adjustments to compensate for contraction or other cold weather reactions.
- Special techniques for handling and storing the equipment.

CLEANING.—Equipment to be winterized must be thoroughly cleaned of all previously applied lubricants. To do this, the photo equipment must be disassembled so that the parts can be thoroughly cleaned and all grease and oil residue can be removed. Cleaning solvent should be used to remove old lubricants from the equipment. However, do not use carbon tetrachloride, lead-free kerosene, drycleaning naphtha, or other dangerous solvents. Care should be taken to prevent solvents from touching those parts which they may damage; i.e., lenses and other optical parts, leather, fabrics, rubber, etc.

After all components are thoroughly cleaned and dried, low-temperature lubricants may be applied and the equipment reassembled.

LUBRICANTS.—The low-temperature lubricants recommended for use when winterizing cameras and other photographic equipment, unless otherwise specified, are: silicone grease, MIL-O-6085 oil, and powdered or flake graphite.

Oils and greases developed expressly for the winterizing of equipment have a low pour point, a low rate of viscosity change, a freedom from corrosion action, low volatility, and low rates of evaporation. Most synthetics such as silicone products are unaffected by temperatures in the region of $-65\,°F$ to $140\,°F$.

### Cold Contraction

When equipment is subjected to low temperatures, the contraction variables of the different materials may cause binding or dragging (which in the case of motion picture cameras can result in intermittent surges in speed). This is detected audibly by squeals, because the contraction tightens two or more parts together more firmly; or, if the materials are adjacent, too great

COLD SOAKING.—Photographic equipment used frequently in cold temperatures and not regularly stored at low temperatures should be cold soaked for 12 to 48 hours before it is used in the cold. A camera, for example, should be "tempered" or brought to approximately the same temperature of cold as it will be operated in. This tempering or cold soaking takes several hours or several days. This soaking period permits all the equipment parts to contract equally to their dimensions for a given cold temperature.

**Moisture Condensation**

Condensation forms on cold cameras and other equipment when the objects are brought into warm air. The warm air (which has a higher moisture content than cold air) is immediately chilled when it comes in contact with cold equipment and gives up its moisture as deposits on the cold object. Although this moisture can be wiped off accessible external surfaces, it also occurs in inaccessible areas and can cause permanent damage. In extremely cold climates, the end result of condensation within equipment is almost always the same—*equipment failure*. A piece of equipment may fail immediately, a week later, or years later, depending on the location and extent of the condensation within. The degree of damage caused by condensation is difficult to ascertain; therefore, it is often overlooked.

Remember, you can move from cold to warmth freely, but your equipment cannot. Equipment, especially delicate mechanical equipment such as cameras, must be brought up to temperature slowly enough that condensation will not occur. The practice of moving cold equipment from cold to warmth by a series of slow stages will prevent the formation of condensation on the equipment. To accomplish this slow-stage warmup of a camera when you are through using the camera, place it, while still outside in the cold, inside a cold case or gadget bag and close the case or bag. Move the case into an indoor room, called the intermediate room, which has a temperature only a few degrees higher than the outside or cold storage room temperature. Leave the case unopened in the intermediate room, long enough for the camera inside the closed case to reach the same temperature as the room. Next be allowed to reach that room's temperature before the case is opened and the camera removed.

This practice eliminates the need to dismantle the equipment to dry it thoroughly which might be necessary if the equipment were brought directly from the cold into a warm building.

Never place cold film in a warm camera, and never place warm film in a cold camera. These actions may cause condensation.

In the polar regions, cameras loaded outdoors, even during a blizzard, and those which have accumulated fine snow particles while in use, are easily cleared of snow by dusting them with a camel's hair brush. The dryness of the low temperature atmosphere prevents any injury to the equipment due to the snow, as long as the equipment is kept cold and the snow is not allowed to melt.

Do not breathe on cold lenses, eyepieces, and focusing screens, intentionally or accidentally. In low temperatures, warm breath becomes fog which forms frost on contact with cold glass and metal. Frost is time consuming and difficult to remove without damage to the lenses.

When the metal surfaces of cameras become very cold, they can stick or freeze to your face when you view through the camera. This is caused by the very cold metal actually freezing the moisture on your skin to the camera. When you remove the camera from your face, some skin may come with it. Some OAEs (Old Antarctica Explorers) glue small pieces of chamois to the metal parts of a camera that would otherwise freeze to the face.

## TROPICAL PHOTOGRAPHY

Our Navy also stations photographers in tropical and near tropical regions or on photographic missions in these areas. In these areas, photography is complicated by such factors as heat, humidity, rust, insects, etc.

Conditions are as equally unpleasant to work under in the tropics as they are in the arctic regions and more detrimental to photographic equipment.

graphic material and equipment are stored can be lowered by the proper use of air conditioning. Air conditioning not only helps ensure favorable and constant storage conditions but will also diminish many of the other problems facing the photographer in the tropics. However, if circumstances do not permit air conditioning, other means for lowering the relative humidity should be used. Photographic equipment can be placed in an equipment storage cabinet having four or five 200-watt electric light bulbs which burn continuously. The air inside the cabinet will be of the same *absolute* humidity as the air outside; however, the higher temperature produced by the heat from the lamps will lower the *relative* humidity inside the cabinet. Equipment that has been properly cleaned and dried will not corrode or rust in a properly designed storage cabinet. Neither will mold or mildew form on leather or fabric parts. Photographic films and papers must not be stored in a heated storage cabinet. They should be kept at a low temperature as well as a low relative humidity.

## CARE OF EQUIPMENT

The high temperatures usually associated with the tropics are not in and of themselves detrimental to cameras and accessories, but intense heat must be avoided except when the equipment is actually being used. When high temperatures are combined with high humidity, fungus is sure to grow on bellows, camera cases, fabrics, and even lenses—rust and corrosion are also likely to occur.

Cameras and other picture making equipment should never be left in hot sunshine for longer than is absolutely necessary nor should they be kept in enclosed spaces where the temperature can get extremely hot, such as the glove compartment or trunk of a car or even in a parked car.

Dust and sand which can be abrasive may be a problem in many tropical climates. It is difficult to impossible to keep blowing dust and sand out of camera equipment. Few enclosures can exclude dust and sand completely. Placing the camera and accessories inside plastic bags may be of some help, but if it is humid, the stagnant air in the bag may promote the rapid growth of fungus. Never keep equipment enclosed in this way for more than a few hours.

## FILM EXPOSURE

A common and wrong impression among many novice photographers is that the intensity of sunlight is greater in the tropics than in temperate climates, so more light is available for film exposure—bull, it ain't necessarily so.

Measurements taken all over the world of the illumination level of sunlight show that under the same atmospheric conditions and with the sun at the same elevation in the sky, the intensity of daylight in the temperate and tropic regions, in general, remain practically the same. The erroneous belief that daylight in the tropics is brighter is a result of the following:

- *Lighting contrast.* In tropical regions where very clear atmospheric conditions prevail, lighting contrast is very high. This tends to give the impression that the light intensity is greater than it really is.

- *Subject reflectance.* In locations where there are vast areas of coral, white sand, and light-colored buildings, much more of the sunlight is reflected. In this situation the camera's diaphragm may need to be stopped down at least one f/stop. However, in many areas of the tropics the foliage is extremely dense and dark, absorbing most of the light. As a result, the camera's diaphragm will often have to be opened up from one to three f/stops above the normal exposure values required for subjects in the temperate zones.

- *Lighting direction.* Lighting in the tropics tends to be strong top lighting, because the sun, for a longer period of the day, is more directly overhead than in temperate climates. The result is that more supplementary lighting should be provided than was needed in temperate zones where lower lighting contrast conditions are normally encountered. The objective of supplementary lighting should be to lighten or soften the deep, dark shadows often created whenever the sun is in a position directly overhead and to reduce apparent contrast.

## CARE OF FILMS AND PRINTS

When film has been removed from its moisture-resistant package, it is subject to

immediate deterioration in the hot, humid tropics. After exposure, the latent image will also deteriorate. All films used in the tropics should be processed as soon as possible after they are exposed. If film processing facilities are not available, the film should be sent away for processing as soon as possible. If you can't process the film or send it out for processing, put it in an airtight jar with a desiccant and place it in a refrigerator.

**Preservation of Processed Films and Paper**

In a hot and humid climate, deterioration of an emulsion caused by residual chemicals takes place rapidly. Always fix and wash films and prints thoroughly.

Processed films should be handled by the edges only, and cotton gloves should be worn to prevent fingermarks. When the films are not in actual use, keep them in clean envelopes to prevent any residue from depositing on them. Some residue may promote the rapid growth of fungus which in turn destroys the film or paper gelatin.

Processed films in a humid climate must be kept dry. The relative humidity where processed films and papers are kept should be maintained at about 40 to 50 percent. A building that is properly air conditioned will have this relative humidity. If the relative humidity is above 55 percent, an electric dehumidifier may be needed or the finished films and prints can be stored in a heated cabinet. As a last resort they can be placed in a metal box with a desiccant.

FUNGUS REMOVAL.—Fungus growth on photographic materials causes gelatin to become soluble in water. Therefore, processed films and prints which have fungus on them can't be washed in water. Instead, any fungus should be removed with cotton moistened with a cleaner such as Kodak Film Cleaner.

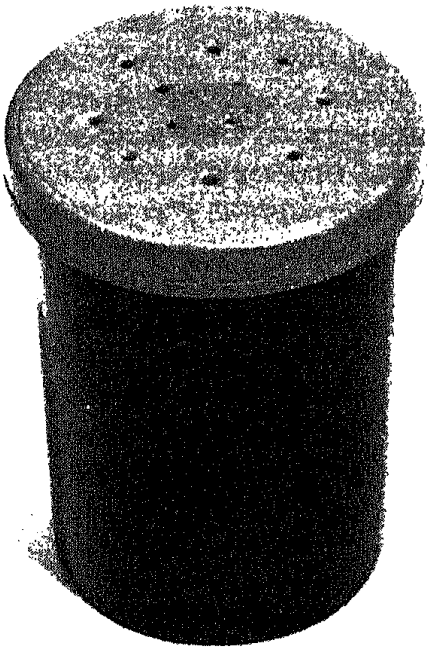
Slides should be removed from their mounts before cleaning and remounted in new, clean, fungus-free mounts. Likewise, after cleaning films, place them in new envelopes.

DESICCANT.—Humidity is probably the worst enemy of photographic equipment and materials in the tropics. If the photographic materials are placed into an airtight container when the air is humid, the conditions in the container are also humid. If a desiccant such as silica gel is placed into the container with the items, the desiccant absorbs the moisture and thus protects the items from the effects of high humidity.

Silica gel resembles coarse white sand in appearance, and like a sponge, it absorbs a considerable amount of moisture. Silica gel is odorless, tasteless, and nonreactive with most materials. It is available in its normal state or colored with a dye that changes from blue to pink when saturated with moisture. After it is dried in a hot oven for a few hours, it changes back to blue and can be used again.

Desiccants are available from Mulliform Desiccant Products, Inc., 1418 Niagara Tr., Buffalo, NY 14213. Desiccants are also available as a standard stock item under NSN 6850-00-389-4824.

Used 35mm plastic film cans make good containers for desiccants. Fill the film cans with desiccant, poke some holes in the top (smaller than the grains of gel) and place the can of desiccant into the film container or even inside your camera equipment cases. The holes in the film can permit moisture-laden air to enter the can where it is absorbed by the desiccant.



In our Navy, high-speed motion picture photography is used to produce slow-motion effects of subjects such as:

- missiles and rockets
- high-speed moving parts, and explosion phenomena
- medical research
- parachute and ejection seat testing
- strength of materials tests
- vibration studies
- wind tunnel tests

Many high-speed motion picture cameras furnish precisely timed images for analyzing velocity, acceleration, range, altitude, spin rate, and other data that are the basis of scientific evaluation and improvement programs.

High-speed motion picture photography projected at the standard or normal 24 fps, or slower if required, extends the audience's viewing time of an event which could originally have taken place in only a fraction of a second. This allows the event to be studied, measured, or analyzed.

The production of high-speed motion pictures requires some special knowledge and equipment. Our intent here is not to cover the subject of high-speed cinematography fully but to give you a basic understanding of its purposes and concepts.

A motion picture, as you know, is actually a series of individual still pictures called frames. These still pictures are taken at regular intervals and then viewed at the same, or at a different regular interval. And as you also know, time or actions can be made to appear normal by taking the pictures at the same fps rate that they will be projected. And you know, if you need to slow down time, you take the pictures at a faster fps rate than they will be projected. In this way, actions or movements that take place too fast for the eyes to see or follow are slowed down so the viewer of the film can see or follow all aspects of the action. The action is thus reproduced in films shot at rates of 100 fps and above.

The term used to describe slow motion that is the result of high-speed photography is *time magnification*. Time magnification is the ratio of the picture taking frequency (fps rate) to the picture projection frequency—or fps rate. Thus:

$$\text{Time Magnification} = \frac{\text{Picture Taking Frequency}}{\text{Projection Frequency}}$$

The purpose of this equation is to give an idea of how much the actual time will be expanded or magnified, so to speak. For example:

An action which took 3 seconds was photographed at 1000 fps. How long will the filmed action last on the screen when the film is projected at 24 fps?

$$\text{Time Magnification} = \frac{1000}{24} = 41.6$$

Thus the actual time it took the original action to occur is magnified 41.6 times. Therefore, the filmed action will last 124.8 seconds when projected at 24 fps. This can be seen in the following equation.

That is:

$$\text{Time Magnification} = \frac{\text{Picture Taking Frequency}}{\text{Projection Frequency}}$$

$$\text{Projection Time} = \text{Time Magnification} \times \text{Actual Action Time.}$$

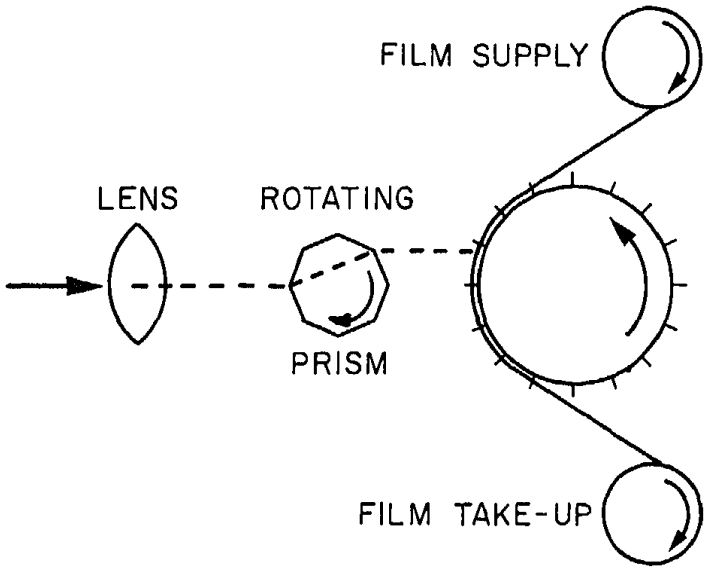
Or as in the above example:

$$\text{Time Magnification} = \frac{1000}{24} = 41.6$$

$$\text{Projection Time} = 41.7 \times 3 = 124.8 \text{ sec.}$$

## HIGH-SPEED CAMERAS

Over the years various types of high-speed motion picture cameras have been developed with different methods of getting the images onto the




film. No single high-speed camera can satisfy all the requirements of high-speed photography. Although most high-speed photography is probably performed at frame rates between about 100 to 500 fps, there are many times when much higher rates are needed.

The two types of high-speed cameras you may most often encounter are intermittent action pin-registration and rotating-prism. Two other types of high-speed cameras which we shall not discuss are streak and ultrahigh-speed.

### Intermittent Action Pin-Registration Cameras

High-speed motion picture cameras which use intermittent action pin-registration are basically the same as conventional movie cameras. You may want to review chapter 1 of module 2 in this training series for information on conventional movie cameras.

Because of the constant stop-and-start motion of the film in this type of high-speed camera, the framing rate is quite limited. Generally speaking, the framing rate of an intermittent action pin-registration high-speed camera is between about 100 to 500 fps.

This type of high-speed camera provides the best quality images as far as image resolution is concerned. They are available in super 8, 16mm, 35mm, and 70mm formats. Some of the advantages of this type of camera are:

- Image quality is far better than the images produced by rotating-prism cameras.

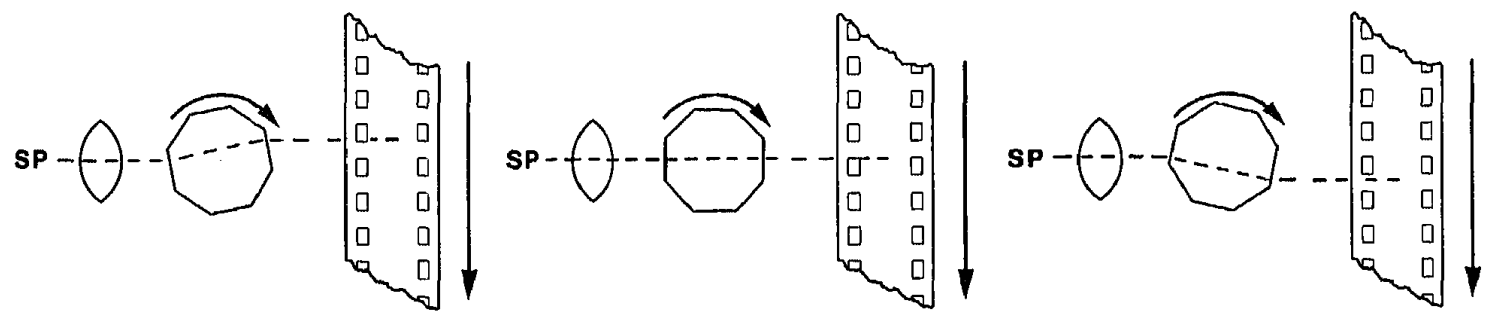
- The film transport speed is lower; therefore film is used at a slower rate which permits a longer recording time.

- Only the lens is in the image path; therefore light transmission efficiency is high.

### Rotating-Prism Cameras

In order to achieve higher frame rates than are possible with an intermittent action camera, some high-speed cameras use a rotating prism so that the film does not have to be stopped for each frame exposure. A prism rotates between the camera lens and the film. Light from the subject passes through the lens and the constantly rotating prism and intermittently exposes the constantly moving film. The film and prism move at a synchronized rate so that the relative motion between the image and the film during exposure is zero.

Some rotating-prism high-speed cameras also incorporate a rotating shutter between the prism and the film. With a shutter, various shutter



a means of adjusting exposure time, at a given fps rate, as well as better image resolution due to shorter exposure times.

Rotating-prism cameras often operate at speeds as high as about 25,000 fps. Because of their very fast fps rates and short exposures, rotating-prism cameras produce images with poorer resolution as compared to intermittent action pin-registration cameras. However, because of their high fps rates, these cameras are especially useful when photographing very fast-moving subjects and when high time magnifications are needed.

## CAMERA RUNNING TIME

Because high-speed motion picture photography depends on the film passing through the film gate at a very fast speed, the length of time that action can be filmed with a given length of film is quite limited. For example, when the camera is operated at 2000 fps and a 100-foot roll of 16mm film is used, the filming time is only 2 seconds. Each high-speed camera has a table of film running times for various fps rates and film lengths.

## TIME-LAPSE PHOTOGRAPHY

At the other end of the scale from high-speed motion picture photography is time-lapse motion picture photography. Time-lapse photography is used to record events or actions which take place too slow for human perception. In time-lapse photography single frames of motion picture film are exposed at predetermined intervals of time. These intervals can range from one frame every few seconds to many hours or even days, according to the slowness of the action which is to be speeded into visibility when the film is projected. With time-lapse photography, the growth or opening of a flower, the movement of clouds across the sky, chemical reactions, etc., all of which may take from a few hours to many days, can be viewed in minutes or seconds. As the name "time-lapse" implies, successive single-frame exposures are made of slow actions, and time is allowed to pass or lapse between exposures. The time between exposures, as we said, may range from a fraction of a second to hours. For single exposure may be made every one-half second throughout the day. At the end of a 9-hour day, 64,800 frames of 16mm film will have been exposed. That is equal to 1620 feet of film. When projected at 24 fps, the 9 hours of filming will be compressed into 45 minutes. Therefore, an Aerographer's Mate studying cloud movement need spend only 45 minutes instead of 9 hours to gather the same information.

Time-lapse motion picture photography records actions at very slow rates. When the films are viewed at a faster frame rate than they were made, time is effectively compressed and actions which took hours or even days or weeks are speeded up so that the viewer can appreciate their complexities.

## TIME-LAPSE CAMERA

A motion picture camera used for time-lapse photography must be able to expose one frame at a time. That is, it must have a "single frame" feature. It must also have a device to trigger the single frame release and a timing device to control the time interval between frames.

Because of the very slow fps rate in time-lapse photography, the camera must be securely mounted to prevent any camera movement. Any camera movement between exposures will cause the subject image to jump wildly about the screen when the film is projected. In this regard, any undesired subject movement must also be prevented. For example, if photographing outdoors you may want to erect a clear windscreen around the subject to prevent the wind from blowing it. The effect of unwanted subject movement between frames is the same as camera shake.

## TIME INTERVAL BETWEEN FRAMES

There are several ways to determine the time interval between frames or exposures, depending upon your needs. Some of the things to consider in determining the time interval between exposures are:

- What is the action and how long does it take?

- Must a given real-time period be covered with just one roll of film?

- Must a given projection time be filled with time-lapse coverage?

- How much film will be required to cover a given real time period at a given frame rate?

For example, if the slow movement of an instrument part is to be recorded for a period of time, you should time how long it takes for the part to travel the distance to be photographed. Say this part takes 3 hours to travel the given distance. If you were to use a frame interval of 30 seconds to photograph the part, you would get only 360 pictures of the part, and the action, when projected, would be fairly fast on the screen. It would be better to get more frames of the moving part. This can be done by reducing the time interval between frames to 5 seconds. Thus you would get 2160 frames which when projected at 24 fps would last 90 seconds. In other words, the 3 hours of action would be compressed into 90 seconds of screen time.

**Formulas**

The following computations are based on using 16mm motion picture film which has 40 frames per foot. The formulas can also be used for other film sizes when the number of frames per foot are known.

**Frame Interval**

- When the length of time the action will last is known and a given viewing time is required,

then:

$$\frac{\text{Action time (sec)}}{\text{Viewing time (sec)} \times \text{Projection fps}} = \text{Frame interval (sec)}$$

For example: The action will last 60 minutes and the required viewing time at a projection speed of 24 fps is 20 seconds.

Therefore:

$$\frac{60 \times 60}{20 \times 24} = 7.5$$

or one frame should be exposed every 7.5 seconds.

- When the action time is known and must be photographed in a given number of frames,

then:

$$\frac{\text{Action time (sec)}}{\text{Number of frames}} = \text{Frame interval (sec)}$$

For example: The action time is 12 hours and must be photographed on 50 feet of 16mm film.

Therefore:

$$\frac{12 \times 60 \times 60}{50 \times 40} = 21.6$$

or one frame should be exposed every 21.6 seconds.

**Number of Frames**

- When both the action time and the frame interval are known, the number of frames required can be determined.

Then:

$$\frac{\text{Action time (sec)}}{\text{Frame interval (sec)}} = \text{Number of frames}$$

For example: The action will last 6 hours and the frame interval is 3.5 seconds.

Therefore:

$$\frac{6 \times 60 \times 60}{3.5} = 6171$$

or 6171 frames of film are required. This is equivalent to 154 feet of 16mm film.

**Projection Time**

$$\frac{\text{Number of frames}}{\text{Projection fps rate}} = \text{Projection time (sec)}$$

For example: The total number of frames used to record an action was 8000. The film will be projected at 24 fps.

$$\frac{8000}{24} = 333 \text{ seconds or } 5.5 \text{ minutes of projection time,}$$

or:

$$\frac{\text{Action time (sec)}}{\text{Frame interval (sec)} \times \text{Projection fps rate}} = \text{Projection time (sec)}$$

For example: The action time was 60 seconds and the frame interval was .25 seconds and the film will be projected at 24 fps.

Therefore:

$$\frac{60}{.25 \times 24} = 10 \text{ seconds projection time.}$$

## ANIMATION

You know how motion pictures record and reproduce images of moving objects. The image positions of objects in motion vary slightly from frame to frame in a motion picture film. When the film is projected, the series of still pictures seems to recreate motion. This, as you recall, is due in part to persistence of vision.

Both regular and animated motion picture films depend on a series of slightly different still pictures and persistence of vision to create the illusion of motion. It is relatively easy to photograph moving objects by recording them in a sequence of still pictures on a motion picture film in the ordinary manner. That is, at 24 fps, etc. However, it is not so simple to make an animated film. For an animated film, the scene must be photographed one frame at a time. Between each frame exposure the subject that will "move" on the screen must be altered slightly. That is to say, for a series to show movement of some object, the object's position must be different in successive frames. Likewise, if drawings are used to show some theory or concept where the illusion of motion is required, each drawing must be slightly different from the preceding drawing. Thus when the series of single frame pictures of each different subject position or drawing is projected in rapid succession, the illusion of motion is created.

for training and other purposes. Statistics have shown that often an animated type of presentation is the best way to emphasize or explain many points which would be lost if presented through the regular motion picture method.

## PRINCIPLES OF ANIMATION

Basic animation of a film story begins with background drawings. These drawings fall into two classes: those dealing with mechanical matters, and those used for cartoon or fanciful presentation of the ideas in the story. An example of the mechanical type of film is an animated movie which depicts the operation of a certain type of motor or engine, detailing, through animation, the movement of its component parts. The second method is the cartoon shown for entertainment or training purposes.

Animation is used widely by the Navy and is often employed to illustrate the operation, maintenance, and repair of mechanical apparatus for example. As already pointed out, the first step is to draw the background area. Animators prepare a series of pictures showing the motor itself. *The animation camera moves in on this base drawing slowly to show a medium shot of some specific part of the engine under discussion. Slowly the engine wall fades away to reveal that part. Often there is movement of this and other parts, and on the screen these supposedly hidden parts appear as the metal around them seems to disappear.* This effect of the disappearing metal of the engine is achieved when one celluloid overlay after another is placed over the background. Each overlay has a section painted on it showing a little more of the interior of the engine. Because the overlay is otherwise transparent, the background of the engine shows through all around that part of the overlay drawing which is opaque. As one overlay after another is placed in position and photographed, the engine appears to open up and reveal its interior. If there is to be a movement of a specific part or parts, each overlay will be drawn with the position of the part altered slightly. The alteration or change in position of the part will be a mere fraction of an inch between drawings and camera exposures. The real item or a model of the item may also be used and

again the movement will be a mere fraction of an inch between frames.

For an animation sequence, on 16mm film, which lasts for 1 minute on the screen, 1440 individual drawings may be needed. Where "rotary" motion may be used, all of these pictures need not be different from each other. Where the exact motion is recurring in exactly the same way, such as clouds floating across a painted sky or a wheel turning, a set of drawings is prepared illustrating the complete cycle. Once properly timed and calibrated, the cycle can be repeated over and over as often as needed, thus saving the preparation of perhaps thousands of drawings.

To achieve another animation effect, the camera is mounted overhead on an animation stand and the drawings are placed on the flat bed of the stand at tabletop level. The camera may be set to descend or ascend at a predetermined speed as the focus is adjusted for each position. In this way the camera can move from LS to MS to CU, etc., and only one drawing may be needed for a given shot progression.

## PICTURE MAKING THROUGH BINOCULARS

When you have a pair of binoculars or a monocular you have a makeshift "telephoto lens" for your camera. You can photograph the magnified image formed by binoculars and obtain pictures similar to those taken with a telephoto lens. There have been many times when Navy photographers have had to make pictures through a 20 Power, Mark III, Ship Binocular.

The optical definition (sharpness, contrast, and distortion) of the image photographed through binoculars is determined by the quality of both the camera and binocular optics. Because the field of view of most binoculars is smaller than the field of view of most cameras, a circular image with dark edges and a loss of definition (vignetting) at the edges of the picture is apt to result.

## MAKING THE PICTURE

For making pictures through binoculars, you line up the binocular and camera so that one eyepiece of the binocular is centered on the camera lens. The eyepiece should be placed close to the camera lens, but not touching it. Stray light from outside the binocular eyepiece and camera lens should be prevented from reaching the camera lens.

The best type of camera for making pictures through binoculars is an SLR. As you look through the viewfinder of an SLR, you see through the camera lens. This makes it easy to align the camera lens with the eyepiece of the binocular and to focus. Simply center the circular image in the camera viewfinder; then set the camera lens focus distance scale at its closest distance, and focus the binocular. When the image in the camera viewfinder is sharp, it will be sharp on the film.

### Exposure

The effective f/number of a camera-binocular system is dependent on the characteristics of the binocular. The camera lens is set at its maximum opening and exposure is adjusted by changing shutter speeds. To determine the effective f/number of the camera-binocular system, multiply the focal length (in millimeters) of the camera lens by the power of the binocular. Then divide the product by the diameter (in millimeters) of the objective (front) lens of the binocular.

Thus:

$$\frac{\text{Focal length of camera lens} \times \text{Binocular power}}{\text{Diameter of binocular objective lens}}$$

$$= \text{f/number}$$

For example: You are using the 20 Power, Mark III, Ship Binocular which has a 120mm objective lens. The camera has a 50mm lens. What is the effective f/number of the system?

Then:

$$\frac{50 \times 20}{120} = 8.3 \text{ or } f/8$$

An automatic exposure camera is not recommended for use in a camera-binocular system and we recommend you always bracket your exposure.

That is:

Binocular power × Camera lens focal length = Effective focal length

Therefore, again using the 20 Power, Mark III, Ship Binocular and a camera with a 50mm lens, the system's effective focal length is 1000mm.

Or:

$$20 \times 50 = 1000$$

Because camera-binocular systems give relatively great effective focal lengths, the slightest camera or binocular movement can result in blurred pictures. To prevent this, both units should be on a rigid support and a cable release used to trip the camera shutter.

## PHOTOGRAPHING OSCILLOSCOPE DISPLAYS

The cathode-ray tube (CRT) is common to many instruments, oscilloscopes, TV, radar indicators, etc. Of these, the oscilloscope is the one you may be called upon to photograph most often. Keep in mind, however, that the basic photographic techniques given here apply to all CRT recording, regardless of the instrument type.

There are two basic types of CRT photography:

- *Single Frame Recording*—which is used when specific displays of data must be photographed. Almost any still picture camera can be used since the film remains stationary during exposure.

- *Continuous Motion Recording*—which is used when data must be photographed continuously over a period of time; for example, the duration of a test. For this type of CRT photography, a special camera is needed because the film is moving during exposure.

## SINGLE FRAME RECORDING

If you have a camera designed for CRT photography, by all means use it. However, if you don't have such a camera, then almost any still picture camera will do.

The camera has to be able to get close enough to the face of the CRT to produce a relatively large image on the film. A view camera, with its expandable bellows is good for this, but a 35mm SLR will work equally well if a large enough image can be produced on the film. A 35mm camera also offers the advantage of a greater film supply.

In order to prevent background fog and reflections, make sure that stray light does not reach the face of the CRT. A shield made of a cone of black construction paper or a dark cloth can be used.

### Adjusting the CRT

Even though you are not expected to understand all about oscilloscopes, you will need at least a basic understanding of what the various oscilloscope controls do. Therefore, when photographing cathode-ray tube displays, it may be a good idea to have someone with you who understands oscilloscopes.

The oscilloscope controls for focus, astigmatism, and intensity must be adjusted for the sharpest trace of useful intensity. These adjustments should normally be made at the sweep rate (the rate at which the trace moves horizontally across the face of the CRT) that will be used when the photographs are made. Many oscilloscopes require different settings or adjustments for high and low sweep rates and also for single sweeps.

The initial focus and astigmatism adjustments should usually be made at a low intensity setting.

There will probably be several pairs of settings which make the CRT image appear sharp; however, careful checking will often show one combination to be best. The objective is to make the image spots as near to a point source of light as possible.

After you have made the focus and astigmatism adjustments, make some trial exposures at various intensity settings to determine which is best for your setup.

### Photographing Stationary Displays

Stationary displays of recurrent patterns are the easiest to photograph. The fastest shutter speed that can be used for oscilloscope photography with a leaf-type shutter is simple to determine:

$$\frac{1}{\text{Sweep rate in hertz (Hz) (cycles per second)}}$$

That is:

If the sweep rate is 250 Hz, then 1/250 second would be the minimum shutter speed that could be used to photograph one complete trace or a single sweep of a recurrent pattern. However, unless you are certain of the calibration or true speed of your shutter, it may be better to use a slower shutter speed (say, 1/125). If you want to record 5 to 10 consecutive sweeps, a slower shutter speed will be required. Five consecutive sweeps in our 250 Hz example would require a shutter speed of 1/50 second.

*For focal plane shutters, don't use a shutter speed faster than that recommended for synchronizing with an electronic flash.*

Many oscilloscopes will give sweep rates in terms of time. The following table can be used to translate shutter speeds into hertz or

Shutter speed to sweep time or sweep frequency

| Shutter speed in seconds | Sweep time in milliseconds | Sweep frequency in Hz |
|---|---|---|
| 1 | 1000 | 1 |
| 1/2 | 500 | 2 |
| 1/4 | 250 | 4 |
| 1/5 | 200 | 5 |
| 1/8 | 125 | 8 |
| 1/10 | 100 | 10 |
| 1/15 | 67 | 15 |
| 1/20 | 50 | 20 |
| 1/25 | 40 | 25 |
| 1/30 | 33 | 30 |
| 1/50 | 20 | 50 |
| 1/60 | 16 | 60 |
| 1/100 | 10 | 100 |
| 1/125 | 8 | 125 |
| 1/200 | 5 | 200 |
| 1/250 | 4 | 250 |
| 1/400 | 2.5 | 400 |
| 1/500 | 2 | 500 |
| 1/800 | 1.25 | 800 |
| 1/1000 | 1 | 1000 |
| 1/2000 | .5 | 2000 |

To photograph an image form on a CRT that appears for only one sweep, the shutter can be left open while the event occurs and the resulting CRT image photographed.

## FILM FOR CRT PHOTOGRAPHY

The spectral emission of the display on a CRT will vary, depending upon the type of phosphor that is coated on the inside of the CRT face. Therefore, the film used to record a CRT image must have a spectral sensitivity that includes the spectral output of the phosphor. Blue phosphors

with orthochromatic or panchromatic film; and orange phosphors with panchromatic film only.

The cathode-ray tube designation number indicates which phosphor the CRT has; for example, 3RP1, 5UP11, 7VP31, etc. The last part of the designation, starting with the "P," indicates the phosphor. The following table can be used to determine the type of film to use for photographing various CRT images.

CRT tube designation
to film type sensitivity

| CRT designation | Film type sensitivity | | |
|---|---|---|---|
| | Pan | Ortho | Mono |
| P1 | X | X | |
| P2 | X | X | |
| P4 | X | X | X |
| P5 | X | X | X |
| P7 | X | X | |
| P11 | X | X | X |
| P12 | X | | |
| P14 | X | X | X |
| P15 | X | X | X |
| P16 | X | X | X |
| P20 | X | X | |
| P31 | X | X | |

There are many films that can be used for CRT photography. The film to be used must of course be chosen on the basis of the type of phosphor being photographed. For general use however, a fast panchromatic film such as Kodak needed, Kodak Royal-X Pan or Kodak 2475 Recording Film or similar films can be used.

## FILM DEVELOPMENT

The developer chosen to process film used to record CRT images should produce clear sharp images. As a statement, D-19 developer is probably one of the best overall developers for CRT photography. If continuous tone images are required, such as when photographing a TV screen, then D-76 developer may be a good choice.

The following table gives suggestions for developing film used to photograph CRT images. The times and temperatures may have to be modified, depending upon the type of CRT recording being accomplished and also upon the processing equipment and techniques.

Film development
for CRT recording

| Kodak film | Type of development | Kodak developer/time /temperature |
|---|---|---|
| Tri-X Pan | For normal speed | D-19/4 min/ 68 °F |
| | For increase in speed of 2 to 3 times. | D-19/5 min/ 68 °F |
| Royal-X Pan | For highest speed (for most phosphors). | DK-50/8 min/ 68 °F |
| | | or |
| | Gives 6 to 10 times speed of Tri-X Pan | D-10/15 min/ 68 °F |

cathode. Unless you need the red sensitivity, you can eliminate recording of cathode glow by switching to an orthochromatic or monochromatic (blue sensitive) film or by adding a green or blue filter to the optical path when using pan film. Be careful not to eliminate the useful output of the phosphor.

- *Room-light phosphorescence*—Most phosphors will phosphoresce slightly for several minutes after exposure to room light. If the CRT face has been exposed to room light, wait several minutes before making the first exposure, thus avoiding an overall fog on the film.

## SUBMARINE PERISCOPE PHOTOGRAPHY

Submarines provide our Navy with a unique opportunity for obtaining intelligence photography because the target (subject) being photographed is usually unaware of the presence of the submarine.

Although few of our Navy photographers will ever be involved in actually doing submarine periscope photography, all senior PHs should have at least a basic knowledge of the subject. Most of this type of photography will be performed by members of the submarine crew who may have only an elementary knowledge of photography. When these people have problems with either the quality of the photography they are producing or trouble with their cameras or film processing systems, they will naturally seek out a PH for advice and assistance. It may also be your responsibility to train the sub's crew in the techniques of periscope photography and film and print processing.

The information provided here is not intended to make you an expert on the subject of submarine periscope photography. Its intent is to provide you with a fundamental understanding of the subject. More in-depth information on periscope photography is published in the *Submarine Periscope Photography Reference Manual* NWP 79-2, NAVAIR 10-1-798. This manual is classified Confidential; therefore you must have a security clearance and a need to know before you can have access to the information contained in it.

high-quality photography. Some of the factors that may affect picture quality are:

- The small target image produced when the submarine must remain a relatively great distance from the target to prevent counterdetection.

- Complex periscope focus and exposure procedures.

- Periscope vibration due to the ship's (submarine) speed and sea conditions.

- Visibility through the periscope head-window which may be reduced by sea spray or surface impurities.

- Reduced target image definition caused by sea surface conditions such as haze, fog, precipitation, humidity, and sea spray.

- Lighting conditions—that is, the direction from which the light is coming in relation to the target.

## TARGET CONSIDERATIONS

### Target Range

Once the submarine crew has decided to conduct periscope photography, their first goal should be to ensure the best possible chance of getting successful photography. To do this they must understand the optimum relationships between their ship and the target, which may be another ship, or an aircraft, or even the coastline, etc.

The ideal target range for photography is one at which the image of the target almost fills the film image area. A good photograph of a target ship, for example, would be made from a range that provides useful intelligence information concerning the armament, electronics capabilities, markings, size of the ship, etc.

A submarine engaged in a photographic surveillance mission has a primary objective of remaining undetected. Therefore, as a practical matter, range considerations for photography are generally subordinate to the requirements of the tactical situation. Periscope power magnification

consideration must be given to exposure and focus adjustments.

### Target Lighting

The ideal target lighting for periscope photography is front to 45 degree lighting. Front to 45 degree lighting will usually provide photographs with the most intelligence value. Back lighting will generally provide target contour or silhouette information only.

## STEREOSCOPIC PHOTOGRAPHY

Stereoscopic periscope photography provides a three-dimensional image when viewed through a stereoscopic viewer. This third dimension, or depth, permits intelligence personnel to determine contour and height differences with a high degree of accuracy.

For true stereoscope, the size of the image on each frame of film must be within about 10 percent of each other, even if one frame has to be enlarged; the pair of pictures should be mounted so that the identical point on each print is 2.33 inches apart.

Only those portions of the photograph that can be superimposed will produce the stereoscopic effect. A bearing change between frames of less than 7 degrees provides identification of objects only; a change between 7 degrees and 20 degrees will permit calculation of object dimensions. Even though an overlap of 100 percent is desirable, a 60 percent overlap is acceptable. The periscope should be trained on the center of the same target for each photograph taken. The optimum target angle on the bow (AOB) is between 80 degrees and 100 degrees. The following figure illustrates the ideal geometry for stereoscopic coverage of a target ship.

## PHOTOGRAPHIC MISSIONS

For the purpose of this discussion we shall consider three general types of photographic reconnaissance missions that a submarine may be type.

### Ship Reconnaissance

Photographs of foreign naval or merchant ships are needed to maintain an accurate intelligence file of their characteristics and capabilities. Reconnaissance photos can be made by periscope photography when the submarine is submerged or even when it is in harbor areas.

Good front to 45 degree lighting will reveal the most details in this type of photography. Back lighting will provide silhouette information only; consequently, back lighting should not be used unless it is the only lighting available under the tactical conditions.

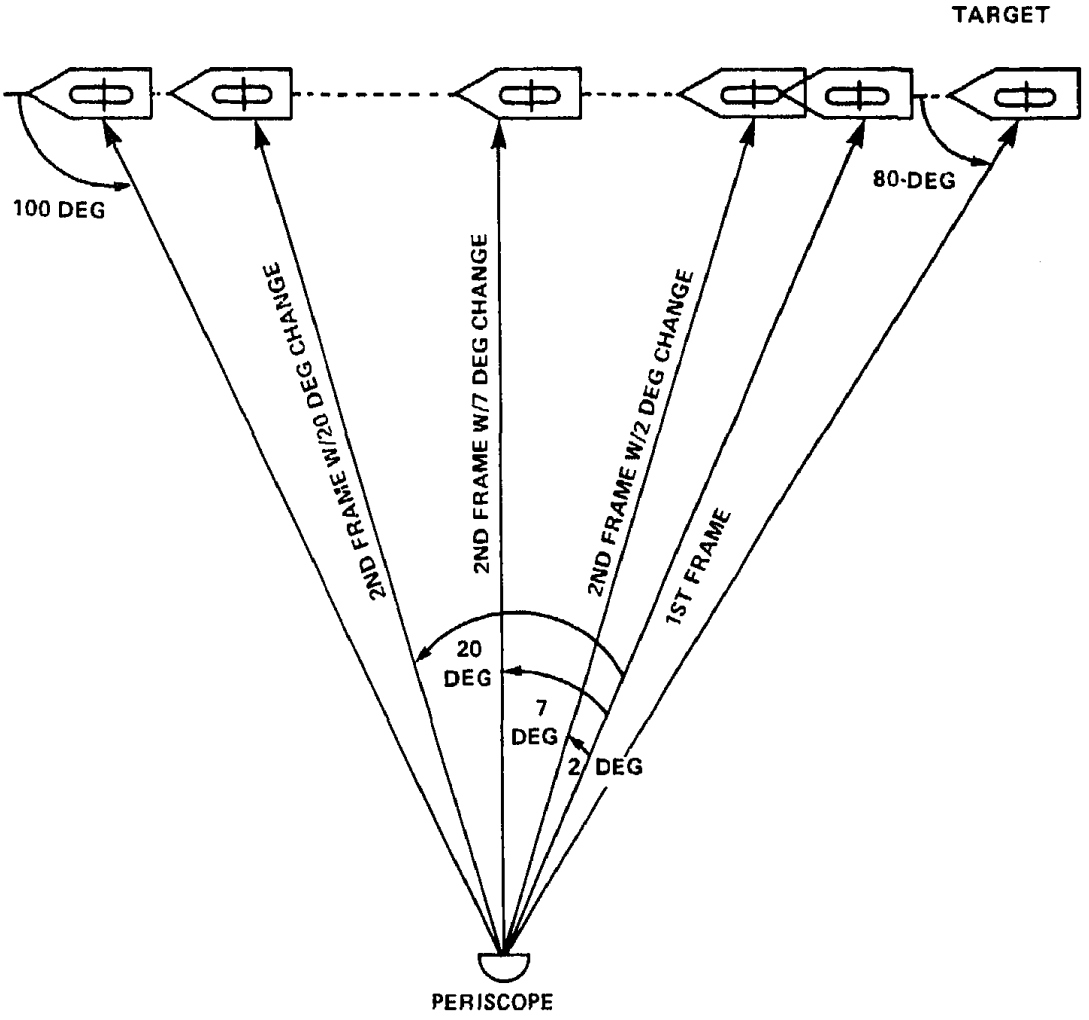
Ships should be photographed from bow-on, broad on the bow, on the beam, on the quarter, and stern-on, if possible. The value of the photographic coverage, of course, increases with the number of angles from which the target ship is photographed.

### Aircraft Reconnaissance

The procedures for aircraft reconnaissance photography using a periscope are basically the same as for surface targets, except that the aircraft move at a high speed. The problem, therefore, becomes one of tracking and focusing simultaneously. Consequently, when a high-speed target is anticipated and critical focus is impossible, the periscope diopter control should be adjusted until the cross hairs are sharply focused.

### Coastal Reconnaissance

Coastal periscope reconnaissance photography is used to produce a pictorial map, so to speak, of a coastline taken from seaward. This type of photography is important when amphibious operations, including SEAL and UDT operations, are being planned. Periscope photography of a coastline is unique in that it provides essentially




NOTES

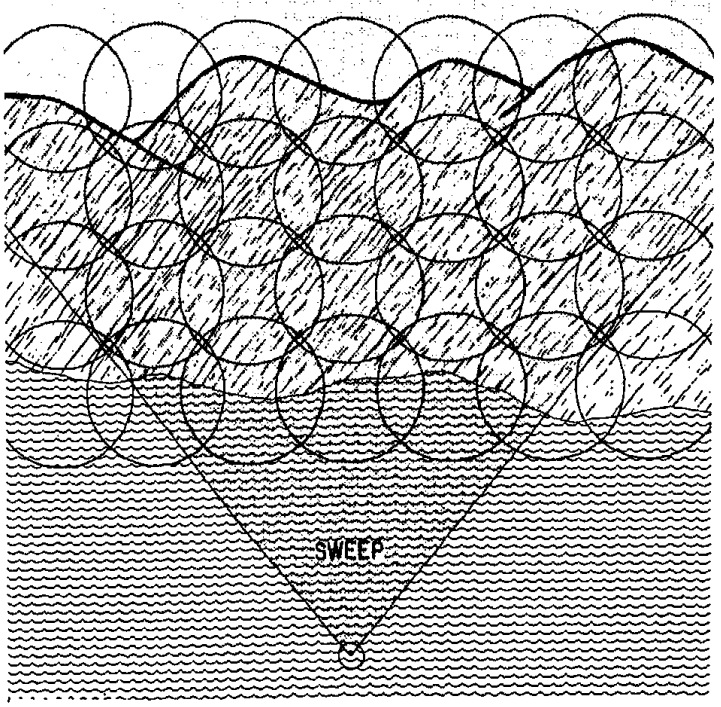
- **AOB (ANGLE ON BOW) SHOULD BE BETWEEN 80 AND 100 DEGREES.**
- **BEARING CHANGE BETWEEN FIRST AND SECOND FRAME IS 2 TO 20 DEGREES.**
- **SECOND FRAME WITH 2- TO 7-DEGREE BEARING CHANGE PROVIDES SHIP ID.**
- **SECOND FRAME WITH 7- TO 20-DEGREE BEARING CHANGE PROVIDES DIMENSION CALCULATION.**
- **PRINTED IMAGE MUST HAVE 60 TO 100% OVERLAP.**
- **PRINTED IMAGE SIZE MUST BE WITHIN 10%.**

**Ideal geometry for stereoscopic periscope photography (angles exaggerated for clarity).**

the same view of the coastline that swimmers and landing troops will have and makes it much easier for them to recognize landmarks and coastal features.

Useful coastal reconnaissance photography generally requires a close range or suitable magnification of the image through increased periscope magnification powers. In addition, when possible, front to 45 degree lighting should be used and pictures with stereoscopic effect made.

Targets of interest usually include prospective landing beaches and harbors. Coverage may include the entire beach or harbor area including flanks, prominent landmarks, orientation points, visible near-shore obstacles such as islands, rocks, reefs, and wrecks. Other important features may include roads, railroads, bridges, coastal defenses, camouflaged installations, breakwaters, piers and wharves, cranes and ship repair facilities, building and storage facilities, ships in port, coastal patrols, and many others.

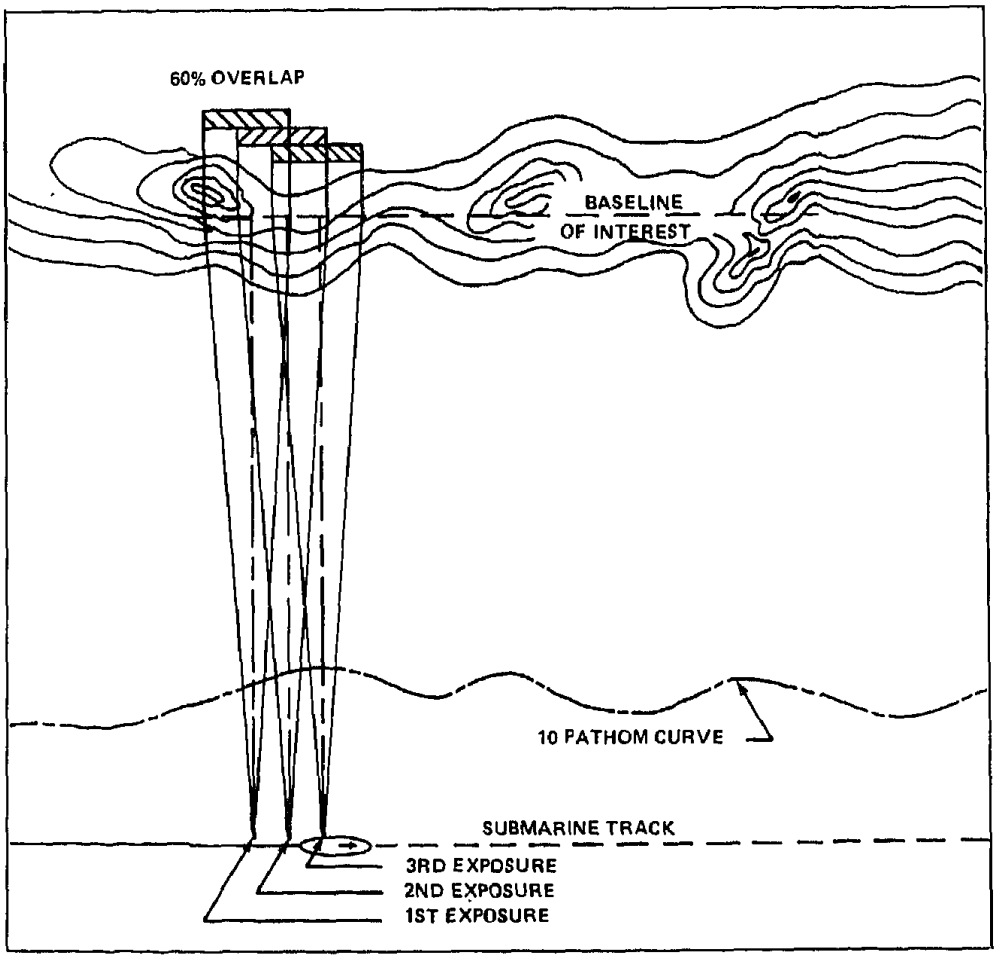



**Vertical and horizontal overlap of the round periscope images to avoid voids at the corners of each photograph.**

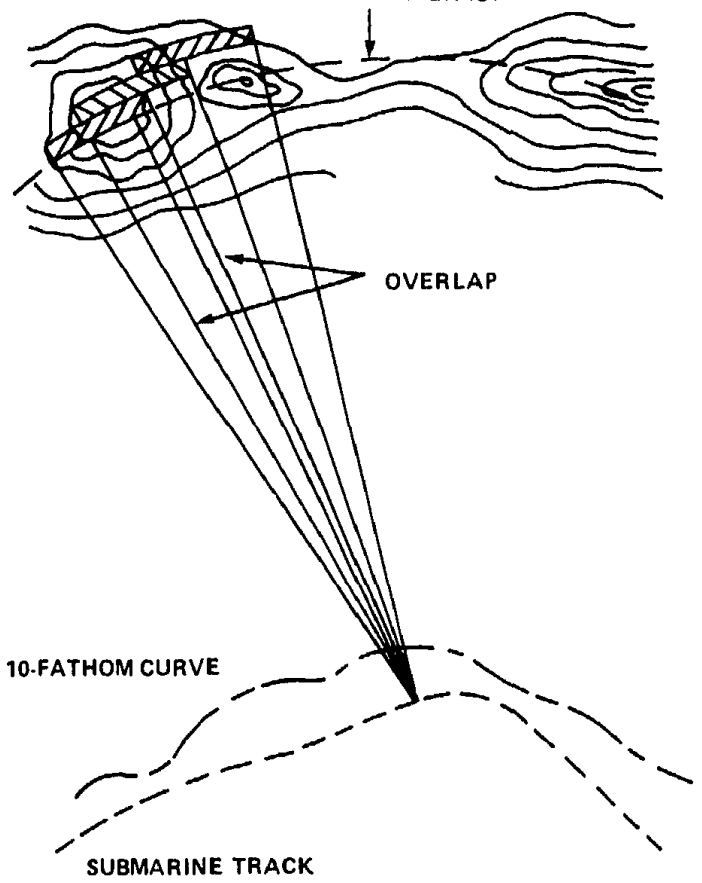
should be made with vertically overlapped photographs so the landmasses beyond and above the coastline are included. When vertical overlap coverage is provided, horizontal overlap must be increased to accommodate the round periscope image area that would otherwise leave voids at the corners of each photograph.

UNDERWAY PANORAMA.—An underway coastal reconnaissance panorama is a series of overlapping photos made as the submarine proceeds on a course parallel to the baseline of interest of the coastline. This is an effective method of gathering photographic intelligence data because in one pass by the submarine, images can be obtained for making:

- a mosaic of the area
- stereoscopic views
- individual prints of any object of interest




**Underway panorama overlap.**



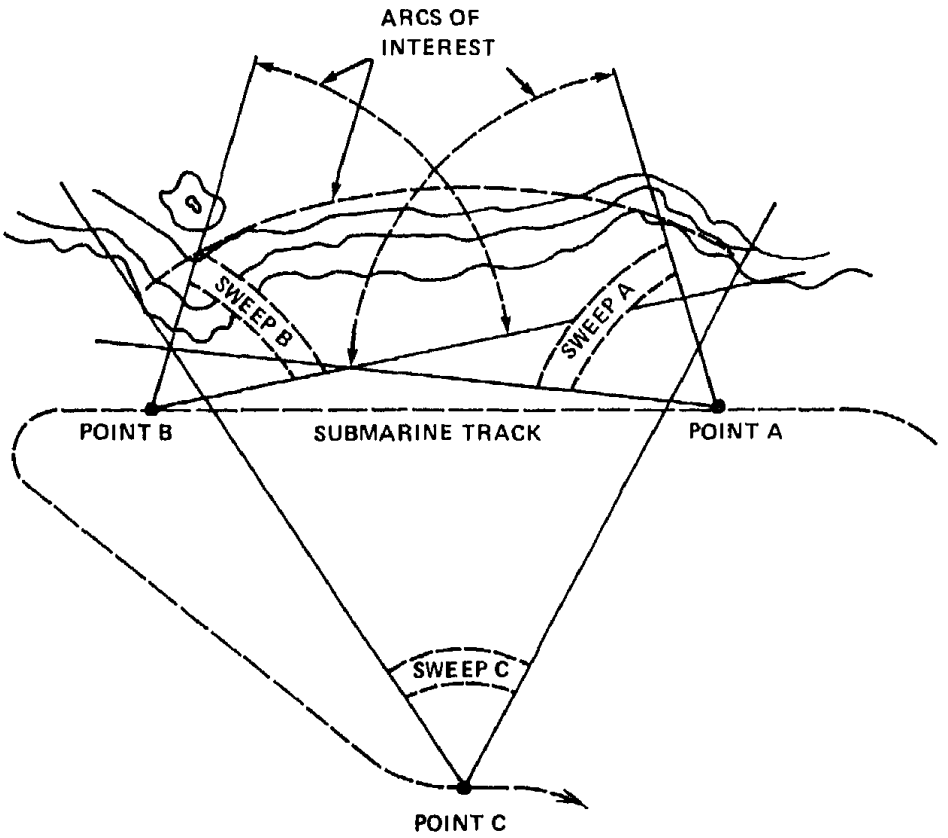

**Sweep panorama.**

the total number of photographs must be computed before the submarine starts its pass of the coastline. When stereo pairs are required, the overlap between frames must be at or very close to 60 percent. You may want to review the section on stereo coverage in chapter 6 of module 2 at this time.

SWEEP PANORAMA.—A sweep panorama is usually made in confined areas where the submarine can't parallel a baseline of intersect. A sweep panorama should provide complete photo coverage of the shoreline.

For a sweep panorama, an area of interest is used rather than a baseline of interest. The periscope is rotated a computed number of degrees between each photograph or the photographs can be overlapped visually while viewing through the camera/periscope system. A stereo effect can be obtained with 60 percent overlap and a target bearing change of at least 2 degrees.

THREE-SWEEP PANORAMA.—Three-sweep panoramas are taken from positions similar to those shown in the next figure. Often the total




**Three-sweep panorama.**

time the periscope is exposed for making a sweep panorama is less than the total time required to make an underway panorama.

> Overlapping photographs made during coastal reconnaissance can be assembled into a single photographic presentation of the area by constructing a mosaic. Making mosaics is discussed in chapter 6 of module 2.

## CAMERA SETTINGS FOR EXPOSURE

Camera systems generally have two ways of adjusting exposure: shutter speed and lens aperture. In periscope photography, however, only the shutter speed is adjusted to control the amount of light the film receives. The light available for exposure in periscope photography is such that the diaphragm is set at its widest opening.

### Shutter Speed Settings

The determination of shutter speed for periscope photography when using cameras that do not have aperture-priority automatic exposure control is essentially dependent upon observation and judgment. It is a function of integrating light conditions with a given film speed, and perhaps bracketing the selected shutter speed in successive exposures.

The basic shutter speed for periscope photography is simply the reciprocal of the film speed. This basic or reference shutter speed may contain some acceptable inaccuracies because some film speeds may have to be rounded to the *nearest* camera shutter speed option. For example, the basic shutter speed for a film speed of ISO 400 is 1/400. If the camera in use does not have a shutter speed of 1/400, then the nearest shutter speed would probably be 1/500, thus the shutter speed is rounded up from 1/400 to 1/500.

LIGHT CONDITIONS.—In submarine periscope photography, five light intensity conditions are considered in determining the shutter speed setting. These five intensity conditions and the required change, if any, from the basic shutter speed are:

- *Bright Sunlight*—A clear day with unobscured sun; the light is most intense with brilliant highlights and dark shadows. No change to the basic shutter speed is required for this condition.

- *Hazy Sunlight*—The sun is just visible through a heavy haze, thin cloud, or fog layer. Modest shadows exist, but considerable target detail is visible because light is reflected into the shadow areas. The basic shutter speed should be reduced by one-half for this condition. For example, if the basic shutter speed is 1/500, the reduced shutter speed would be 1/250.

- *Cloudy Bright Sky*—The sun is obscured by a solid layer of relatively thin clouds. The light is diffused with very little trace of shadow. The target has a low luminance (contrast) ratio. The basic shutter speed should be reduced to one-fourth for this condition. That is, if the basic shutter speed was again 1/500, the reduced shutter speed would be 1/125.

- *Cloudy Dull Sky*—The sun is totally hidden behind a thick cloud layer, and the light intensity is low. The shutter speed should be reduced to one-eighth of the basic shutter speed. For example, if the basic shutter speed were 1/500, reducing this to one-eighth would result in a shutter speed of 1/60.

- *Cloudy Dark Sky*—Very dark clouds which are frequently associated with an approaching storm. The shutter speed for this condition should be reduced to one-sixteenth the basic shutter speed, or 1/30 if the basic speed was 1/500.

Front to 45 degree lighting is the most desirable for periscope photography and requires no adjustment to the basic or reference shutter speed. However, when side or back lighting conditions are encountered, an adjust-

tions describe the relative amount of light reflected from the target to the periscope.

- *Front lighting*—The sun is directly behind the periscope. This condition produces normal contrast conditions with minimal shadows and requires no adjustment of the basic shutter speed.

- *Side lighting*—The sun is at a position of from approximately 70 degrees to 90 degrees in relation to the side of the periscope. This condition produces varying shadows that outline target detail, but may obscure objects in shadow areas. To gain shadow detail the basic shutter speed should be reduced by one-half.

- *Back lighting*—The sun is behind the target and the periscope is looking into it, only a silhouette of the target with little or no shadow detail is visible. The basic shutter speed should be reduced to one-fourth for this condition.

SUN ALTITUDE.—The basic shutter speed should also be adjusted for the altitude of the sun in relation to the horizon. For example, during morning and evening periods when the sun is low in the sky; i.e., for about 2 hours after sunrise and for about 2 hours before sunset, the basic shutter speed should be reduced by one-half.

FILTERS.—When the yellow filter is used for making pictures, the basic shutter speed should be reduced by one-half.

Combining Shutter Speed Factors.—The many factors which affect the determination of proper shutter speed must be considered either singularly or in combinations, depending on the variables present at the time of photography. If, for example, the basic shutter speed is 1/500 and the subject is front lighted by bright sunlight at 1100 and no filter is in the optical system, then no adjustment to the basic shutter speed will be required. However, given the same basic shutter speed with a target that is side lighted in late afternoon with hazy sunlight, then the shutter speed may have to be reduced to one-eighth of the basic speed, and so on.

Shutter speed bracketing should always be routinely considered in doing periscope photography because of all the influences that can degrade the accuracy of shutter speed selection. Bracketing is done by making three pictures, one at the computed speed, and one each at the next faster and next slower shutter speeds.

## PERISCOPE FOCUS

The focus of the target image through a periscope optical system is much more critical for photography than for human viewing. While human vision may perceive an image to be sharp, the same image when photographed may not be sharp. Proper focus for periscope photography is achieved solely with the periscope diopter focus knob, using an experimentally determined setting. The camera focus is set at infinity.

### Focus Factors

The ability to achieve a properly focused image is affected by the following factors:

- Cleanliness of the periscope headwindow, staunching window, eyepiece, and camera lens.

- Misalignment of camera-to-periscope mating.

- The periscope prime-focus viewfinder eyepiece not in focus to the operator's eye setting, including prescription eyeglasses.

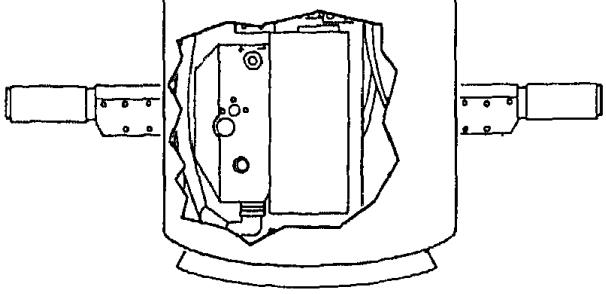
- Periscope magnification power shifting.

- Lack of yellow filter in the periscope optical path.

- Own ship and target speed. Two other factors which may affect image definition by causing the image to be blurred because of image motion are the submarine and/or target speed and the sea state.

### Focusing Procedure

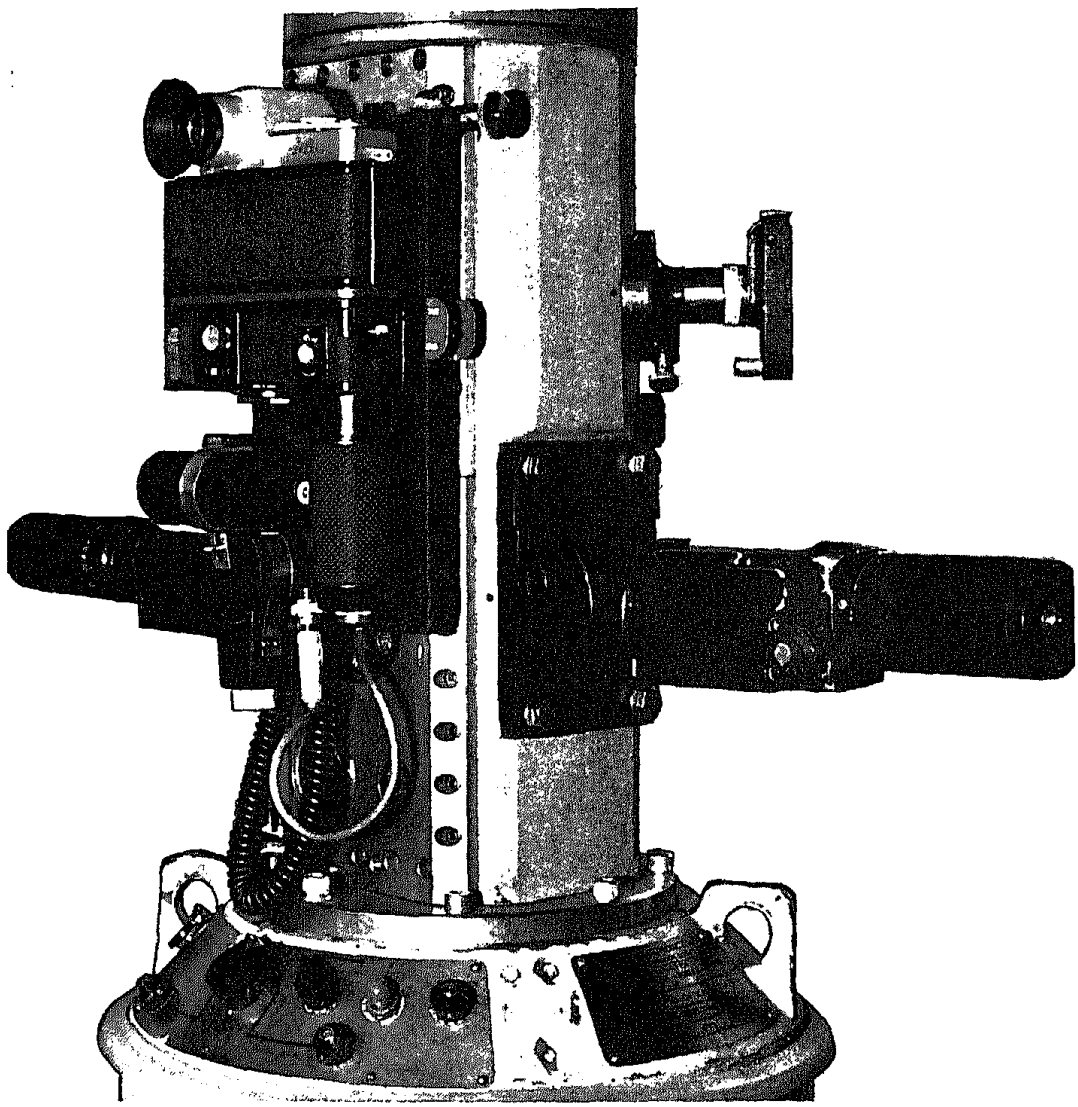
*The focusing procedures given here for periscope photography are applicable to Type 2, 8, and 15 periscopes and do not apply to the newer periscopes such as the Type 18 which has a built-in photographic subsystem and has an automatic focus mode.*



**Cutaway view of Type 18 periscope with KG-29A Type 18 periscope camera installed.**

has been developed. CIFP must be determined, before a mission, for each periscope-camera combination, and validated regularly.

The procedures for determining the CIFP include making a picture of a target at a range of about 2000 yards, starting with the best eyeball focus of the target or telemeter cross hairs. Use of an actual target is preferred. Successive pictures are made with the diopter focus knob adjusted in one millimeter increments. Subsequent analysis of the *finished photographs* (not the



**Prime-focus mode (camera used without a lens).**

CIFP tests are given in NWP 79-2, NAVAIR 10-1-798.

## PERISCOPE/CAMERA SYSTEMS

At the time of this writing, there are four basic camera systems associated with periscope photography:

- The KG-29A Type 18 periscope camera
- The KS-93 Topcon lens-to-eyepiece system
- Tech/Ops Kit Topcon prime focus mode system
- KS-149A Nikon F-3 system

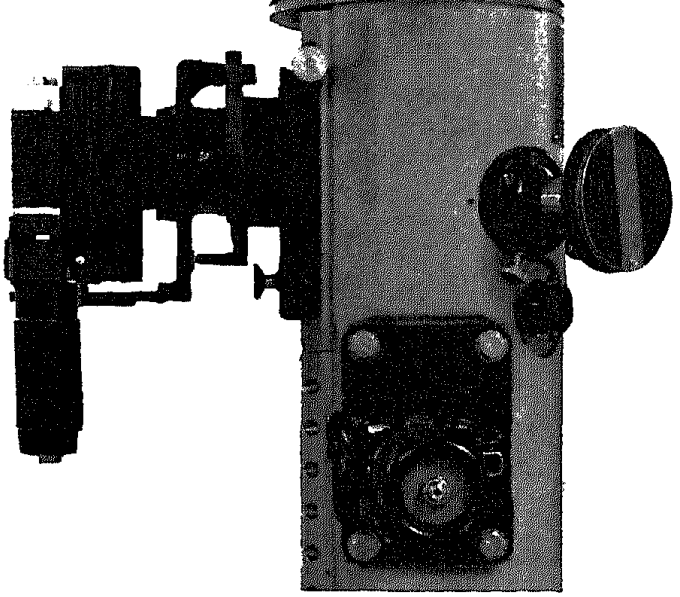
The operation and use of these systems are described in detail in NWP 79-2, NAVAIR 10-1-798; therefore, only a general overview of the systems is given here.

### KG-29A

The KG-29A Type 18 periscope camera is part of the image-motion-compensated camera system (IMCCS), and is built into the Type 18 periscope as an integral component. This camera can be used to obtain high resolution, intelligence-quality photography. A photograph of the image viewed through the periscope eyepiece is made on 70mm film.

### Topcon Super D Camera

The Beseler Topcon Super D is a 35mm SLR camera. The image to be photographed is viewed through the camera and periscope optical system with the camera mounted onto the periscope. The exact image seen is recorded on the film.



**Lens-to-eyepiece mode (camera used with a lens).**

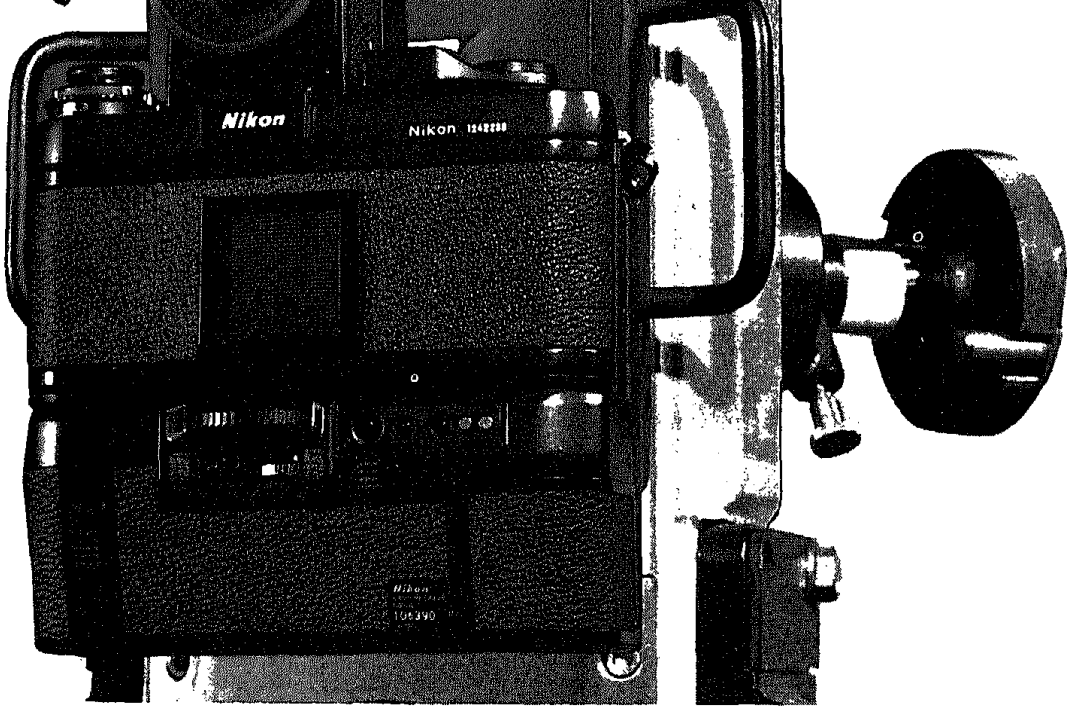
MODE SELECTION.—Periscope photography using the Topcon camera has two modes of operation. Mode selection generally depends upon the target range and lighting conditions. The modes are:

- *Prime-Focus Mode*—A camera without a lens is used and the image is projected directly through the periscope optics, with the eyepiece, onto the film.

- *Lens-to-Eyepiece Mode*—A camera complete with lens is used and the image is projected through the periscope optics, eyepiece lens and camera lens, onto the film.

### KS-149A Nikon F-3

The Nikon F-3 is a 35mm, aperture-priority, automatic exposure camera. The image to be photographed is viewed through the camera viewfinder and the periscope optical system. A lens is not used on the camera.




KS-149A camera used in the primer-focus mode.

# THE ZONE SYSTEM OF FILM EXPOSURE[1]

The zone system of exposure is a direct, workable way of always getting the most out of your film, paper, and chemicals. Perhaps the most important thing to be learned from practicing the zone system is the concept of previsualization. The word itself means simply "to see ahead of time." Isn't that what the whole picture making process seems to be about? You make a picture and try to make it "come out" like some notion in your head. We all realize that we can't take a scene which is three-dimensional by nature and produce an exact copy of it in a two-dimensional photograph. We realize too that a black and white picture is not the same as the subject which is actually colored. We cannot reproduce exactly the scene which is before our camera; we can only come up with an approximation. Nevertheless the photograph can and does have a life of its own!

If you understand what photographic materials can do, you can learn to form a mental image of the finished photograph before you actually trip the shutter. Your mental picture may, of course, be one of many things. You may have a mental picture which is unlike the scene before you. Your mental conception may be a composite of two or three or more pictures; it may be sharp or fuzzy. This is where your individuality comes in. Knowledge of photography allows you to make successful photographs from these mental images.

With the zone system, you must first previsualize, then plan a strategy of exposure and development and produce a print to make the previsualized image a reality. The success of the process is dependent upon how well the print matches your mental picture, not how well it matches the original scene. This idea should not be too surprising as you've been doing it all along without realizing it. You would seldom return with a print to the site of the photograph just to check and see how well it "came out." Zone system previsualization intensifies this same process.

The first step after previsualization is exposure of the film. With the zone system there is no such thing as over- and underexposure, or over- and underdevelopment either, except by accident. Granted your exposures will vary, therefore some negatives will look thin and others dense, but you will have made them that way on purpose. Thus the thin negatives and the dense ones, since they were made that way with a certain kind of print in mind, are not improperly exposed. Any exposure is correct if it produces the negative best suited to materialize your mental picture.

Mastery of exposure is dependent upon your knowledge of the film, camera, and meter used. Experience in a zone system reduces the problems of exposure to reflex actions which aid you in "capturing" that previsualized mental picture.

Likewise, film development is no longer to be considered in terms of "over" and "under." Through a simple set of tests you will learn the effects of a range of developments upon your own film. Knowing how your film reacts to different developments will enable you to pick the one to get your mental picture on paper the way you "saw" it in your head and felt it in your heart. Any development is correct if it produces the negative most suited to materialize your mental picture.

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[1] From "*The New Zone System Manual*" by White, Zakia, and Lorenz, published by Morgan & Morgan, Inc., Dobbs Ferry, NY. Reprinted with permission of Morgan and Morgan, Inc.

make the kind of prints you want from negatives that are an integral part of the process. Of course you will vary slightly (within a zone) the print exposure, development, dodging, and burning-in to put the finishing touches on your previsualized image.

After producing a finished print, you should take the time to evaluate how close you came to accomplishing the task of recording the original previsualized image. This is part of what is called postvisualization. It takes some mental gymnastics, but you'll find them delightful after a bit of practice. What you learn each time in this process prepares you for the next photograph.

it has presented the facts as clearly and concisely as possible. During postvisualization you have a chance to re-read your manuscript to see how well you are communicating your ideas through pictures.

This then is an overview of the zone system. As a serious Navy photographer, you will surely want to know much more about the zone system and how to use it to produce professional quality photography. We, therefore, recommend that you read "*The New Zone System Manual*" by Minor White, Richard Zakia, and Peter Lorenz, published by Morgan and Morgan, Incorporated, Dobbs Ferry, NY.

# VIDEO DISPLAY TECHNOLOGY

Eastman Kodak Company has demonstrated an advanced video display technology which extends the usage options of film images. The system demonstrated a video display capability on television that utilized electronics to both enhance and reformat film-based images.

In the demonstration, an operator scanned a 15-image disc negative and selected various images which were enlarged or cropped for viewing on a TV screen.

This "personal control" of display space on the TV screen is possible via a remote control unit that allows quick sequencing of film images, zooming in for a closer look at a particular image, and recomposing the image for better composition.

By inserting a disc in the video display unit and using the remote control feature, one can quickly sequence through 15-disc images, zoom in for a closer look at a particular image, or recompose the image on the television screen for a better view of one of its elements. This gives the viewer personal control of display space. Because of the imaging capacity of photographic film, images from even a small part of the negative are sharp and clear.

The zoom and crop feature could allow users to reformat pictures until the most pleasing result is obtained. By encoding this new format on the magnetic core of the disc the image could be returned to the screen for subsequent viewing in the newly chosen form. The encoding would also permit a photo lab to deliver a new, recomposed print to customers. Using the encoded information on the disc core, photofinishing printing equipment could be made to automatically print the customer's negative in his chosen format.

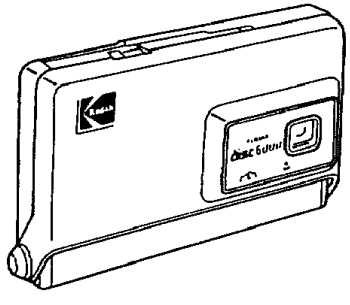
First, and probably the most important part of the new technology is the heart of the system—a solid-state imaging sensor that converts film images into electronic signals for television. This advanced sensor yields a picture comprising more than 350,000 picture elements for an extremely detailed television image.

The system demonstrated is but one of a number of extensions of photography being considered by Kodak planners. This system demonstrates the versatility of electronically enhanced film-based imaging. The power of modern electronics offers unique ways to build on the richness of film images and to gain extended access to display space. It could give consumers another way to view their pictures in addition to photographic prints.

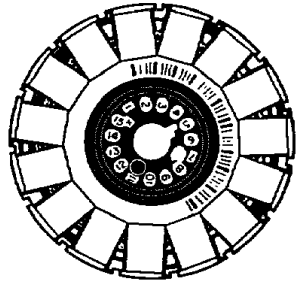
Although the video display system Eastman Kodak Company demonstrated is based around their disc camera and disc film images, we may someday see a video display system using other film image formats in our Navy photo labs. Imagine the convenience of being able to view our negatives and crop them while sitting at a console in a well-lighted room. The encoded information and film images would then be sent to the darkroom where the worker simply places the negative into a printer and the rest is done by the printer "reading" the encoded information and producing a perfectly cropped, focused, and exposed print.

# KODAK VIDEO DISPLAY TECHNOLOGY

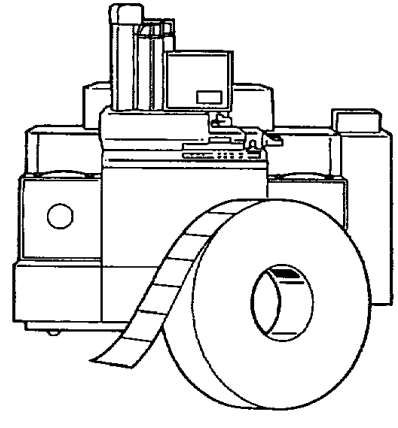
1
DISC CAMERA



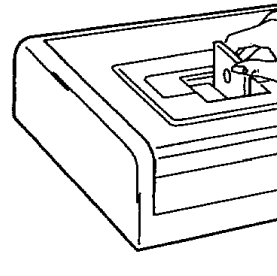
2
DISC FILM



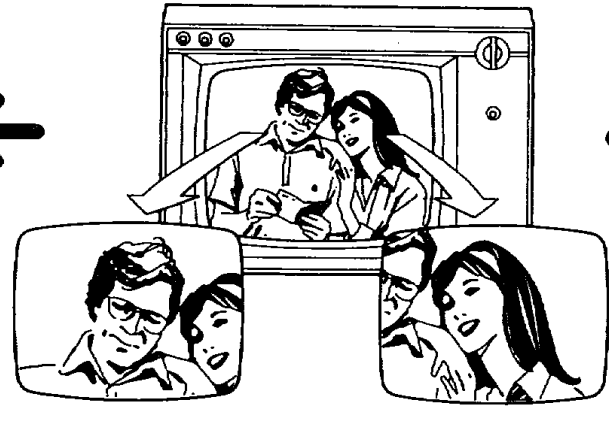
3
PHOTOFINISHING



PROC
AN



VIDEO DISPL
5



RECOMPOSED TV IMAGES
6

PHOTOFINISHER
PRINTS/ENLARGEMENTS
FROM RECOMPOSED IMAGES
7

AII-2

# APPENDIX III

# BLACK AND WHITE HAND PROCESSING FOR PERMANENCE

As a photographer, you should be concerned with processing films and prints so they are as free as possible from the residual chemicals that hasten deterioration. You may not always be successful in producing stable results unless you are aware of the principles that underlie removal of residual chemicals from photographic materials.

Generally, processing for permanence or archival quality does not require any different methods or added steps in the process other than those normally used; careful, systematic work is the keynote.

In some of your photographic work, the stability or permanence of prints may not be important; they are used and discarded immediately afterwards. "Stabilized" prints—prints in which the silver halide is converted to compounds that are only temporarily stable—are intended for such use. Negatives, on the other hand, should always be fixed and washed properly. There have been many cases where a seemingly unimportant negative has become valuable after a time, due to historical or unusual circumstances. If saving time is important, negatives can be refixed and rewashed after prints have been made.

For most purposes, fixing and washing should be carried out according to the instructions given by the manufacturers of sensitized materials or the recommendations given later in this appendix. Negatives and prints which are processed properly can be expected to last for many years under normal storage conditions. Photographs intended for permanent records should be processed to achieve archival permanence. Archival permanence implies total removal of chemical residues harmful to the photographic image or its support.

*In photographic practice, the terms "stable," "permanent," and "archival" are relative or comparative terms. They shouldn't be taken to imply indefinite resistance to the effects of destructive agencies.*

## CAUSES OF DETERIORATION

Small amounts of hypo remaining in photographic material after processing will eventually combine with the silver of the image and form silver sulfide. The result of this reaction, as seen in a black and white negative or print, is a stained and faded picture. Stability is also impaired by traces of complex silver compounds that remain in the photograph due to a shortened fixing time or to an excessive amount of silver in the fixing bath, a condition which exists when a fixing bath has been used beyond its useful capacity.

A further cause of deterioration in negatives and prints is exposure to unfavorable atmospheric conditions. You have little or no control over this aspect of stability, but you should be aware that the effect of residual hypo and silver is greatly accelerated by high temperature coupled with excessive humidity, as well as by sulfurous matter and harmful gases in the air. Photographs intended for use in tropical climates or in industrial areas should, therefore, be processed for maximum stability.

In addition, the particular granular structure of a silver image has a bearing on its tolerance

ticular film or paper for special treatment. The purpose of fixing is to dissolve the undeveloped, light-sensitive silver halides from the emulsion. The products of this reaction are complex silver compounds. As more material is fixed in a bath of hypo, the concentration of these silver compounds in the hypo solution becomes greater. When the concentration reaches a certain critical level, some relatively insoluble silver compounds are formed; these compounds can't be removed by washing. Moreover, as the concentration of silver in the fixing bath increases, so does the time required for complete fixing. This means that you should check your fixing baths frequently to make sure that they are not used when the amount of silver they contain has reached a critical level.

## FIXING

To make a negative or print as stable as possible, two conditions must be met.

- All the undeveloped silver halides in the emulsion must be dissolved by the fixing solution so that the silver compounds thus formed can be removed from the material by washing.

- Both the fixing chemicals and soluble silver compounds must be removed from the emulsion and its support by thorough washing.

## FIXING TIME

A single sheet of film or paper fixes in a relatively short time in a fresh fixing bath, because fresh solution is in contact with the whole surface of the material throughout the immersion time. When a batch of prints or negatives is fixed in a tray, a different condition exists. The sheets of material adhere to one another, and prevent access of fresh solution to the surfaces. For this reason, photographic materials must be agitated and separated constantly throughout the fixing time. The effect of lack of agitation is often seen as a stained patch in the center of the negative

turers generally include a safety factor tha helps to compensate for the difficulties i fixing material in batches and for the slowdow of the fixing reaction by a buildup of silve compounds in the hypo solution. The fixin times recommended, however, should not b exceeded, particularly in the case of pape prints.

## PRACTICAL LIMITS FOR CONCENTRATION OF SILVER IN FIXING BATHS

When the concentration of silver in a fixin bath reaches a certain level, insoluble silver com pounds are formed that fail to leave the materia in washing. A higher concentration of silver ca be tolerated in a fixing bath for negatives tha in one for papers. This is because chemical solu tions are not absorbed by the film base. Remova of residual chemicals is, therefore, relativel simple. As a general rule, this concentration i reached when a film takes twice the time to clea that the same film would take in a fresh bath

In fixing papers, the situation is more com plex; chemical solutions can be absorbed by th paper base as well as by the emulsion. As a result residual chemicals are much more difficult t remove by washing. When a single fixing bath i used for prints it must be tested frequently otherwise, the permissible level of silver can easil be exceeded without the processor operato being aware of it. A more certain method of fix ing prints is to use the two bath system.

## FIXING NEGATIVES

A few negatives can be fixed in a tray if the are separated and handled carefully. In batc processing, the best method is to use suitable filr hangers suspended in a tank. In this way the film are always properly separated. Fixing is carrie out with the minimum of handling, and conse quently, less damage.

to clear. If it takes twice the time to clear that the same film would take in a fresh bath, the silver should be reclaimed from the fixer and the solution discarded. Remember, some types of film take much longer to clear than others; therefore, the same film must be used to check the clearing time in both the fresh bath and the used bath. Whether it is exhausted or not, a tank of hypo should have the silver reclaimed and the solution should be discarded after 1 month of use.

## FIXING PRINTS

Prints which are hand processed are usually fixed in a tray—and often in large quantities. Consequently, precautions must be taken to be sure of complete fixing if the prints are to be stable.

Always use trays or tanks that are large enough to permit easy handling of the prints. For example, not more than twelve 8 × 10-inch prints can be fixed properly in an ordinary 16 × 20-inch processing tray.

The following question is often asked: "Should prints be placed in the fixer face up or face down?" The answer is most photographic paper floats on the surface of the solution and cannot be left unattended for any length of time no matter which side is up. Bubbles form under a print that floats face down; consequently, some areas are only partially fixed. The effect may not be apparent in a black and white print, but it will be seen as circular, purplish stains in a print toned by one of the sulfide processes. A print that floats face up exhibits the same effect, but the purplish stains are irregular in shape.

### Life of a Print Fixing Bath

The useful life of a print fixing bath is shorter than a bath used for fixing negatives. There are two reasons for this.

- Due to the absorbent nature of paper, especially, nonresin-coated paper, silver compounds from the hypo are difficult to remove from the material during washing.

ship between fixing time and washing time in print processing. The recommended fixing time should always be followed precisely. Times in excess of those recommended by the manufacturer permit the hypo solution, and the silver compounds it contains, to penetrate the paper fibers, as well as the spaces between the fibers. Paper in this condition is difficult to free from residual chemicals by washing. After a period of time, the effect can be seen as an overall yellow stain that extends right through the paper base. It becomes apparent immediately if the print is toned by one of the sulfide processes.

### Fixing Prints in a Single Bath

As successive sheets of paper are fixed in a bath of hypo, the quantity of silver in the solution builds up. When prints are fixed, a critical concentration of silver is reached after comparatively few sheets of paper have been fixed. The recommended number of 8 × 10-inch prints per gallon of solution (or the equivalent area in other sizes) is 100 for routine processing. However, if prints with the minimum tendency to stain are required, the bath should be discarded after only thirty 8 × 10 sheets of paper per gallon have been processed. The above figures give only an approximate estimate of the condition of a fixing bath, because the amount of silver compounds added to the solution by a print depends on how much of the silver halide in the emulsion was developed to metallic silver. Obviously, less silver halide would be left in a very dark print than in a very light one.

### Twin-Bath Fixing

It is always preferable, when hand processing prints, to use the twin-bath-fixing method. This method is much more efficient and affords a considerable savings in chemicals. The prints are fixed for 2 to 5 minutes in successive baths. The major part of the silver halide is dissolved in the first bath, and the remainder is dissolved or rendered soluble by the second bath.

base. Under suitable conditions, negatives are freed from residual chemicals after 20 to 30 minutes of washing.

Washing prints can be a problem; chemicals may be absorbed by the paper base, and to remove them completely by washing alone is difficult. Under favorable conditions, nonresin-coated prints are washed well enough for most purposes after 1 hour. If these prints are intended as permanent records, they should be treated with a *hypo eliminator* to remove the last traces of hypo that remain after normal washing. Resin-coated (RC) prints wash in about 4 minutes and hypo eliminator is NOT recommended for use with them.

## WASHING EQUIPMENT

The water in any tray or tank used for washing photographic materials should change completely every 5 minutes. This rate of change should be achieved without excessive turbulence, which can damage the films or prints.

A test to determine the rate of change of water in a washer can be made quite simply. Add a small quantity of potassium permanganate solution to the water in the tray or tank and observe the time the color takes to disappear. Before you make this test, be sure the water in the vessel is not contaminated by hypo—weak permanganate solution is made colorless by hypo—and the tank is free from the slimy deposit that accumulates in washers that are not cleaned frequently. Since such a deposit retains chemicals, you should clean the tank or tray before making the permanganate test. By the same token, dirty washers are a source of stains on prints, which are difficult to account for. Washing equipment should always be kept clean by frequent wiping and rinsing. A 10-percent solution of sodium carbonate helps to remove slimy deposits from the interior surfaces of washing apparatus.

dissolved in it. The degree of hardness has little or no effect on stability, although very soft water permits gelatin to swell excessively; this may be troublesome in some processes.

If you use water from a well or other untreated source, it may contain sulfides or dissolved vegetable matter. The presence of sulfides can be detected by an odor of hydrogen sulfide when the water is heated. A greenish color in the water indicates dissolved vegetable matter. These impurities can be removed by suitable filtration or treatment.

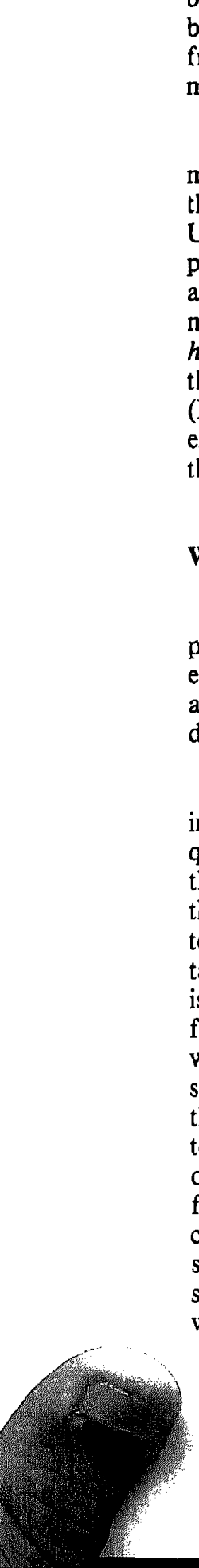
Generally, it is safe to assume that water is satisfactory for photographic washing if it is clear, colorless, and does not have a sulfide odor upon heating.

### Using Seawater

Seawater is very efficient for removing hypo from negatives and prints. This fact may be of value to those who do processing on board ship. Remember, however, that salt is detrimental to the stability of a silver image, particularly if residual hypo is present in the material. Therefore, if you use seawater for washing, it is imperative to remove the seawater salts by a final wash of at least 5 minutes in fresh water for fiber-base papers. Because of the short wash time required for RC papers, seawater washing would be superfluous and defeat the purpose of RC paper. RC papers should be washed in fresh water only.

### Wash Water Temperature

The temperature of the wash water has a definite effect on the rate of removal of hypo and silver complexes from both films and prints. Experiments have shown that a temperature of 40 °F will slow the removal of residual chemicals while a temperature of 80 °F will speed it up. When practical considerations as well as the physical characteristics of film and paper are taken into account, the most suitable range of temperature for washing is 65 to 75 °F.



to move about too rapidly. The Kodak Automatic Tray Siphon is an attachment that provides adequate water change in a shallow tray without the turbulence that may damage the films.

Large batches of film should be suspended in hangers and washed in a tank. With suitable hangers, films can be washed this way. For good water circulation, place the inlet in one corner at the bottom of the tank. Allow the water to overflow at the top edges of the tank. A single outlet at the top tends to make uniform currents that might leave certain areas in the tank comparatively stagnant, and so reduce the rate of complete water change.

To conserve water and reduce the cost of washing, do not wash negatives much longer than the recommended 20 to 30 minutes. It is also wasteful to use an unnecessarily high rate of water flow or to wash negatives in a tank much bigger than that needed to accommodate the size or quantity of material being washed.

## WASHING PRINTS

Since paper base is absorbent, it is difficult to wash the last traces of hypo and silver from nonresin-coated prints. For most purposes, adequate washing of nonresin-coasted prints is achieved in 1 hour if the water in the washer changes completely every 5 minutes. However, the wash time and the rate of water flow are both meaningless if the prints are not separated constantly so that water can reach every part of each print throughout the washing time. A well-designed washer can do this fairly well with small prints up to 5 × 7 inches; larger prints need frequent handling to keep them separated. A number of well-designed washers are available from photographic dealers. No washer can perform satisfactorily if you wash too many prints in it at one time. Use two or more tanks and wash

As stated before, seawater removes hypo from photographic materials more quickly than fresh water. Investigations into this effect have shown that certain inorganic salts behave like the salt in seawater. Unlike seawater, however, they are harmless to the silver image. Hypo eliminators, such as **Kodak** Hypo Cleaning Agent, are a preparation of such substances. Their use reduces the washing time for both negative and fiber-base prints. At the same time, nonresin-coated prints attain a degree of freedom from residual chemicals almost impossible to obtain by washing them with water alone. A further advantage in using hypo eliminators with fiber-base prints and negatives is that adequate washing can be achieved with much colder water.

### Using Hypo Eliminators For Films

Rinse films in fresh water for 30 seconds to remove excess hypo, and then immerse them in hypo eliminator solution for the recommended time with agitation. Then wash them for 5 minutes in a tank where the water changes completely in 5 minutes. To avoid streaks, drying marks, and the formation of water droplets on film surfaces, bathe films in a wetting agent for the recommended time, then hang them up to dry.

### Using Hypo Eliminators For Fiber-Base Paper

Rinse fiber-base prints for 1 minute to remove excess hypo. Treat prints in the hypo eliminator for the recommended time. (The treatment time will be different for single-weight and double-weight paper.) Then wash the prints in clean running water—single-weight for 10 minutes and double-weight for 20 minutes, both with normal water flow and constant agitation.

# APPENDIX IV

# WATER CONSERVATION IN PHOTOGRAPHIC PROCESSING

Water has generally been very plentiful and relatively cheap—except on board ship. But an expanding population and growing industry are changing the ratio of supply and demand so much that water conservation even at our shore stations has become a concern.

Because large quantities of water are essential to photographic processing, it is worthwhile to examine your laboratory processes and practices from time to time for ways to economize in the use of water. Water consumption can often be reduced appreciably with no loss in the quality of processing.

Our photographers have become accustomed to using more water than they actually require in their day-to-day work. Such habits are difficult to break, so there will probably be a need for a "campaign" to save water. You could ask public works or the ship's engineer to conduct a laboratory-wide water conservation audit to help you determine ways of reducing water usage. Your workers should be continually instructed and reminded of the need to conserve water and periodic reports on conservation can be required.

An engineer can place quick-connect meters at strategic places in the water lines. With such meters, the engineer can find out the volumes being used for various purposes. The engineer may even find that wash waters are carelessly left running when not needed.

Another step could be for the engineer to suggest modification of production schedules and have fewer, but longer, processing runs because startups and shutdowns require much water. If production rescheduling is done, you must balance good service against water consumption.

No savings can be made in the volume of water needed for making processing solutions, but this is of little consequence because the amount is such a small percentage of the total need. Of considerably greater importance is the saving that can be realized in the processing of film and paper, both by hand and by machine.

## RISK OF DEVIATING FROM SPECIFICATIONS

Instruction manuals for processing give specifications relative to product, machine, kind of wash, rate of wash, etc. Whether or not the wash continues to completion, changes in washing techniques and rates should be tested experimentally, and deviations from the control standards for the product and the process should be noted. In practice, many recommended washing times and procedures have a safety factor that will allow significant reductions in water volume with little risk of endangering quality standards.

## REUSE OF COOLING OR HEATING WATER

Water for cooling or heating processing solutions, etc., makes up a large proportion of the water that is commonly run off as waste, and much of this could be conserved.

Cooling water for air conditioning, heat exchangers, air compressors, etc., should be reused in processing. These types of water flows may first have to be filtered and brought to proper temperature.

The heating systems for processing should be closed systems so that the water can be

temperature-controlled water. A fixed-volume, constant-temperature bath with a thermoregulator and a mechanical mixer to maintain circulation will eliminate this waste.

## CONTROL METHODS

Maximum-flow regulators can help prevent a greater flow of water than is needed. A regulator can be placed at every sink or processing machine

through the use of a salt bath between the fix an
the wash. Here, the cost of one more tank an
the chemicals must be considered.

Hypo eliminator is a fast and efficient mean
of removing residual hypo in films and paper. Th
use of this balanced salt bath will both lesse
processing time and substantially reduce wate
usage. Hypo eliminator is widely used with blac
and white film and fiber-base paper and, whe
processing specifications permit, with man
color materials.

# APPENDIX V

# PREVENTING AND REMOVING FUNGUS ON PRINTS AND FILMS

When photographic films or prints are stored or kept for any length of time in an environment having a relative humidity above 60 percent, there is a good chance for fungus, mold, or mildew to grow on the emulsion or the back of film. High humidity is quite usual in tropical areas, including much of the United States, especially during warm summer months. High temperature alone, however, without high humidity, will not cause fungus problems.

Fungus spores are in the air everywhere, regardless of the temperature and humidity. And like plant seeds, fungus spores will germinate and grow whenever the conditions are favorable.

Whether or not you can do anything to correct the effects of fungus growth on photographic materials depends upon the degree of growth and whether it started to grow before or after exposure and processing.

You can't correct the damage fungus causes when it occurs on unexposed or unprocessed film or paper. The areas where fungus grew on unexposed or unprocessed materials will show a change in density on black and white materials and a change in density and color on color materials.

You can reduce the danger of fungus damage on unexposed films by keeping the moistureproof packaging sealed or intact until you're ready to use the film. Opening the packaging will make it easier for fungus to grow on the film. Also, process the film as soon as possible after exposure. Fungus can attack unprotected exposed film inside or outside your camera.

When fungus occurs on processed films, the damage to the image is not immediate; but, if it is discovered in time, some steps can be taken to remove it and to prevent its recurrence. If the growth proceeds too far it may cause permanent damage to the image. This is likely to be more serious with color film, because the growth of fungus may release substances which affect the dyes. With either black and white or color films, fungus growth may also etch or distort the gelatin of the emulsion or the backing.

## PREVENTING FUNGUS GROWTH

The best method of protecting processed films against fungus growth is to store them in a cabinet or file in which the relative humidity can be kept below 50 percent. You can do this by using a desiccating agent, such as silica gel, placed with the film in a moistureproof package such as an airtight can or polyethylene bag, etc. Silica gel lasts indefinitely, but it must be reactivated periodically to remove the absorbed moisture. You can do this by heating it to between 250 and 300 °F in a vented oven until the color indicator turns deep blue. Heating for about 30 minutes is sufficient to reactivate small quantities of silica gel; larger quantities require 2 or 3 hours.

One ounce of silica gel is sufficient to protect about 50 slides in mounts, about 200 feet of 16mm film, or a total weight of about 4 ounces of negatives plus their storage envelopes.

When desiccation is not convenient, considerable protection against fungus attack is afforded by storing processed films so that they are protected from dirt and dust. There is some advantage in using storage boxes of metal, polyethylene, or styrene rather than wood or cardboard, as the latter tends to absorb and hold moisture. One way to dry slides that are stored without desiccation is to project them occasionally.

You can lower the relative humidity in a metal cabinet of the type used for office supplies by

top and bottom to allow a slow but constant change of air through the cabinet.

Any form of surface contamination is likely to promote the growth of fungus. When you are handling films make every effort to keep from getting fingerprints on the surfaces. Remove any accidental fingerprints immediately with film cleaner.

Store processed film in photographic negative envelopes or protective sleeves. These are designed to protect film from dirt and moisture and are free of chemical residue which may be harmful to the film.

## USE OF FILM LACQUER

Coating small format black and white and color negatives with film lacquer such as **Kodak** Film Lacquer can protect against fungus growth. **Kodak** Film Lacquer contains a fungicide, and also offers mechanical protection so that if fungus does grow, it is kept on the lacquer surface and prevented from attacking the emulsion for a considerable time. If fungus growth is discovered before it penetrates the lacquer coating, it can be removed along with the lacquer by the treatment described later in this section. After a thorough drying, the clean emulsion surface can be relacquered.

To apply **Kodak** Film Lacquer to the cleaned film, first place the negative, emulsion side up, on a clean, dry, flat surface, preferably a sheet of glass. Fasten the edges of the film to the glass with masking tape, taking care to cover any perforations because the solvents in **Kodak** Film Lacquer will attack the back of the film. Pour a small quantity of film lacquer into a small, clean receptacle, and apply it with a camel's hair brush. Allow the negative to dry for 10 minutes in a dust-free location. Discard the unused film lacquer; do *not* return it to the bottle. Clean the brush with a 1-percent solution of sodium carbonate (washing soda) or sodium bicarbonate (baking soda).

**Kodak** Film Lacquer should not be used to relacquer color or black and white transparencies, because of the risk of streaking and uneven application. It is not adapted to dipping

*apply to films. Therefore, if you use any film cleaner, first make a test on an unimportant piece of film.*

## REMOVAL OF FUNGUS

It is not safe to use water to remove fungus from color or black and white films, because fungus growth on the emulsion usually makes the gelatin soluble in water. The use of water or water solutions will, therefore, damage the image.

You can remove most surface fungus from negatives and slides by wiping them with soft plush, absorbent cotton, or chamois skin moistened with **Kodak** Film Cleaner. (Remove slides from their mounts before cleaning, and use new mounts after cleaning.)

In the case of films that are protected with **Kodak** Film Lacquer, if the fungus growth has not penetrated to the emulsion, the lacquer can be removed by soaking the film in a dilute solution of sodium bicarbonate (baking soda). Dissolve a level tablespoon of soda in a pint of water at 60 to 70 °F. Agitate the film in the solution for 1 minute, and rinse it for 1 minute in water at 60 to 70 °F, preferably about 60 °F. Bathe the film in film wetting agent according to the directions on the label, and hang the film up to dry in a dust-free place. Thorough drying will usually require several hours.

## CAUTION

Do not use this treatment if the fungus growth is at all extensive. As mentioned above, if the fungus has penetrated the emulsion, some of the emulsion may be removed by any treatment with water. Make a test with the least important slide or section of film before treating the more valuable ones.

type sold by paint stores and hardware stores for thinning shellac—*rubbing alcohol is not satisfactory*. Any ordinary household ammonia, either cloudy or clear, can be used if it is reasonably fresh and strong. Clean small format negatives or color slides by wiping their surfaces with absorbent cotton saturated with the alcohol-ammonia mixture. Support the film, emulsion side up, on a smooth nonporous surface, such as a sheet of glass, to avoid scratching or marking the film base. You can clean color negatives by dipping and agitating them in the solution at room temperature for no longer than 2 minutes. Dry the films thoroughly before remounting them.

No satisfactory method is known for complete restoration when the gelatin has become etched or distorted by the fungus. If the fungus is in the gelatin backing only, it is possible to remove the backing, but the film may curl excessively as a result.

Small format slides from which fungus growth has been removed should not be remounted in their original mounts. After being dried thoroughly, the slides should be remounted in new mounts. Take care to avoid touching the film surfaces, either by wearing clean cotton gloves or by using a clean lintless tissue between your fingers and the film.

Experience in the tropics with large numbers of glass-mounted slides has shown very little trouble, although there may be a tendency for fungus to grow on the inside surface of the glass. When you are mounting slides in glass, it is important to have both the film and the glass dry.

electric lamp. Slides mounted in glass should be stored in a dry place. In damp locations, moisture condensation and ferrotyping (glossing) can occur on glass-mounted slides.

## FUNGUS GROWTH ON PRINTS

Photographic prints stored under conditions of high humidity are also subject to damage by fungus. The growth of fungus on a print surface can cause dull spots on an otherwise glossy print. Fungus can degrade the gelatin in the emulsion layer to such an extent that localized stripping will occur—removing the image and exposing the paper base. Insects are attracted to fungus and may damage the emulsion layer.

## TREATMENT OF PRINTS WITH A FUNGICIDE

Black and white prints which are undamaged by fungus growth can be protected by treatment with a fungicide, such as Hyamine 1622[1]. For example, after a thorough washing, soak the prints for 3 to 5 minutes at room temperature (not below 70°F), with occasional agitation, in a 1-percent aqueous solution of Hyamine 1622. Hyamine treatment may produce a very slight coloration with some photographic papers, although with the majority of papers it is not detectable. In any case this hue is less objectionable than the fading, the yellowing, and the fungus damage that may occur on untreated papers.

[1]Available from Rohm & Haas Co., Independence Mall, W., Philadelphia, PA 19105

# COMPUTERS IN AUDIOVISUAL PRODUCTION

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Computers are complex tools and their capabilities are truly mind-boggling. They contain literally millions of pieces of information and require specialized programs. But the single most amazing thing about the current generation of computers is not their electromechanical complexity, but their operational simplicity.

Today anyone in any AV activity can operate a computer. You don't need to commit fantastic amounts of money, acquire specialized computer personnel, or get a degree in electrical engineering. However, you do need a desire to gain the advantages, cost-efficiency, and maximization of productivity computers offer.

Bremson Data Systems, for example, has had an integral part in making the promise of computers a reality, in bringing computer technology to daily production operations in the photographic industry. Before computers can assume a more prominent role in our Navy audiovisual production facilities, senior Photographer's Mates and audiovisual officers must feel comfortable with computers. We hope this appendix will be a step in that direction.

## HOW WE GOT WHERE WE ARE

A decade ago if you said you were considering adding a computer to your lab most people would have thought you were crazy. And, the truth is, you would have been!

Back in the 1950s, computers were big, delicate, and expensive. They were housed in glass-walled sanctuaries where the air was meticulously conditioned and filtered. Mere mortals could not get near them, much less use them! A specially trained operating staff ministered to the computer, carefully scheduling work. So when you had a job to run, you submitted it to them and waited for the results. And you waited—often for days.

Obviously, such computers were more trouble than they were worth to most photo labs. For computers to be truly practical and useful they had to get out of their shrines and into the real world.

Recognizing that need, researchers began working on technologies that led to what are known today as minicomputers—machines that are small enough, cheap enough, and tough enough to be used by the people who need them.

Minicomputers paved the way for the computerization of a whole new range of jobs: jobs that were too small for the multimillion dollar giants, yet too big to be worked out on the back of an envelope. They also provided the means to decentralize computing power, allowing the end users direct control of their own inexpensive computers instead of having to wait for a central data service to schedule and run the problem. Significantly, minicomputers brought the advantages of interactive computing to light.

The advent of interactive computing meant that people could receive immediate feedback on their work—that minicomputers could be used directly with instrumentation and machinery, responding in real time as events actually occurred.

Minicomputers made it possible, practical, and economical for thousands of new and creative applications of computerization to appear.

## WHO NEEDS A COMPUTER?

You do.

That is, you do if information and data are important to your productions.

Or if you handle a large amount of information and data during your normal course of business.

Or if parts of your unit are physically separated from other parts (the farther apart, the greater the need).

Or if you use a formal information system (that is, anything more organized than casual chats with co-workers).

Or if rapid recall of production data and data used for production would increase your efficiency.

Or if a great deal of your production process requires accurate and speedy repetitions of movement.

Or if you don't have ready access to important internal information.

Or if you anticipate future growth.

Or if you'd like to lower production costs.

Or if you're interested in maximizing the productivity of your sailors.

Or if the optimization of existing systems and resources sounds good to you.

Or if you'd like to enhance your professional reputation.

Or if you want to keep up with the changing technology of AV.

## WHAT'S SO GOOD ABOUT COMPUTERS?

In the most basic sense, computers are sophisticated filing systems. Like the familiar row systems light years apart. Computers manipulate, correlate, and integrate information so that it becomes more meaningful, more useful, or more important. And that puts computer users far ahead of those who don't use them.

The vast superiority of computers over conventional information systems can be traced to a few primary differences:

- Computers are capable of handling a substantially larger collection of more complex data.

- Computers make access to data easier and quicker.

- Computers can transmit data to remote users or other mechanical systems with unmatched accuracy and speed.

Sounds good, but what do those differences mean in practical terms, in daily application? A lot. Computers produce benefits that more than cover their initial cost. They save you money over the long run.

Take a look at the difference you can expect a computer to make in your work.

### LOWER DIRECT COST

A computer system often displaces more than its initial cost by reducing manpower requirements, clerical personnel for example. Or, if not replaced, their cost-effectiveness can be dramatically increased.

### LOWER INDIRECT COST

A computer system streamlines your operations, frequently having a favorable influence over areas not directly controlled by it. For example, the faster you can respond to a change in audiovisual technology, the better service you can provide, the more professional your image. In the case of audiovisual, where materials change commonly, a computer system can make the difference between survival and success.

inaccurate readings, or vary its performance and control. It does what it has been told to do with unfailing speed and accuracy every time, all the time.

## QUICKER ACCESS TO DATA

No more searching for something you know is "somewhere." Just punch in the question and the answer is at your fingertips—instantly. Likewise, when a computer controls a mechanical system—a color printer for instance—the information required to run that system is always ready.

## THE RIGHT INFORMATION GETS TO THE RIGHT PERSON

It's called direct access and it's very important. It means eliminating unnecessary delays or layers of people. It means the person who needs the information gets the information. It means efficiency.

## THE SKY'S THE LIMIT

When it comes to the size of data pool, there's no limit to what a computer system can handle. As long as you choose a computer system that can expand to keep pace with your expanding data pool, your computer system can stay in business as long as you operate.

## LEARN MORE FROM WHAT YOU KNOW

Because computers can manipulate and correlate data, what you know can tell you more. When properly implemented in a computer system, relationships of variables, quality assurance, production and inventory records and accounting and job order files, just to mention a few, can provide you with new wealth of information.

That's what you can expect from a good computer system. Chances are you'll get some benefits you didn't expect as well.

wires qualify for the term "computer." There is a lot of confusion these days between what should properly be called a computer, a minicomputer, a processor, or microprocessor.

Broadly speaking, a computer is a machine which performs as it has been told (programmed) to perform. It is a system that collects, stores, manipulates, and outputs data to allow for more efficient control and management of a process or procedure.

Technically speaking, the distinction among microcomputers and microprocessors and minicomputers and miniprocessors is becoming increasingly hazy for two reasons: first, there is a genuine overlap in certain capabilities and functions; and second, the terms have suffered widespread misuse. To set the record straight, the textbook definitions are:

microcomputer—a minicomputer that incorporates a microprocessor for its Central Processing Unit (CPU).

> Microcomputers—limited by their relatively slow speed, low power, and small memory capacity—are best used as "personal" or "home" computers a la Radio Shack's offerings.

microprocessor—an integrated-circuit chip that contains the complete Central Processing Unit (CPU). Microprocessors alone are commonly used to provide the functions (day, date, time of day, stopwatch, etc.,) on digital watches.

minicomputer—a relatively inexpensive (up to several thousand dollars), general purpose computer that usually has higher speed and larger memory capacity than a microcomputer.

Clearly, the definitions beg the question of the importance of the CPU. The CPU is the brain of the computer. It is the portion that controls sequencing, does instruction decoding and performs arithmetic and logical operations. It is,

of the brain of the computer. The microprocessor is the basic component of the larger microcomputer. A microprocessor alone is like an engine without a car: it may run, but since it's not connected to anything, it won't get you very far.

Obviously, it takes more than just one microprocessor chip to make a computer system work for you.

In order for a computer to be truly functional in a wide variety of audiovisual applications, it must have at the absolute minimum a way to create programs, save them, run them, and report the results. The main reason microprocessors cost less is because they are, in fact, only part of a computer system. They don't include "extras" like printers and terminals that are actually requirements. They have limited capacity. They are relatively primitive when compared to minis and micros. For those reasons, and many more, you should approach microprocessors with extreme caution. Beware of their limitations. What's great for playing video games and balancing your personal checkbook might be incapable of performing sophisticated audiovisual management functions.

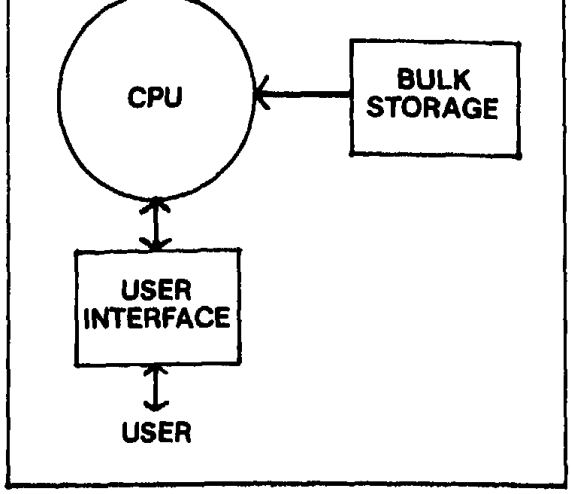
Now, let's take a closer look at the major components of a computer system. The following sections are applicable not only to microcomputer and minicomputer systems but also main frame computers (the big daddies of the computer family that often require several rooms of space and a tightly controlled environment).

## HARDWARE

Hardware is the computer machinery, the physical wires, terminals, conductors, transistors, cables, switches, chips, etc. As we shall see, the hardware is divided into various classifications by function, but no matter what it does, as long as you can see and touch it, it's hardware.

## SOFTWARE

Software is the thought patterns of a computer. The term "software" is the catch-all




for how the computer has been taught (programmed) to think, act, and react. Software and hardware are interdependent and the sophistication of one determines the limitations of the other. An example of the importance of this interrelationship can be seen in the distinction between single-user and multiple-user systems. No matter how many physical terminals a system might have, it will not be able to give multiple users simultaneous access to the computer unless it contains a software program for multiple use.

## COMPUTER PROPER

The computer proper is the device that starts monitors, and controls all the component parts of the system. The computer proper contains the CPU along with the memory, power supply, and input/output device controllers.

## MEMORY

Because memory is of critical importance in a computer system, the types of memory and memory access deserve your attention. Memory is always stored information—the difference is in how and where it is stored.

irst be moved from mass storage to working nemory by the CPU before it can be used.

The difference between the two is similar to he difference between what is contained in a book pened in front of you and what is contained in book on a shelf behind you. You have access o the information in both books, but the time t takes, the steps it requires, and the energy eeded to get that information differs.

Because the working memory is, quite literlly, what you will actually be working with, its ize is of great importance to you. The size of the vorking memory determines the number, size, nd complexity of the programs you can execute. t makes the difference between a computer ystem solving problems for you or creating them.

The working memory is used to store two ypes of information in binary form. The first type s the program which is a list of instructions oded in binary form. The program directs the PU to perform tasks on the data.

The second type of information stored in the vorking memory is data that has been pulled from nass storage or has been input from various other eripheral devices such as video terminals. This ection of memory is used by the CPU for temorary storage during the computation process or or information waiting to be output.

As mentioned above, computers require a nass storage device. Therefore, the type of equipnent used to store information in mass storage nerits your consideration. Certain types allow aster reference than others. Some are particularly uited to one kind of information. And all require t least two machines—one to transfer informaion and one to hold it permanently.

One final word about memory concerns torage capacity—it varies greatly. Before you can valuate the merits of a computer for your operaion, you must determine your needs precisely. hen examine memory storage and access in light f your requirements.

## NPUT/OUTPUT DEVICES

These are sometimes called "Peripheral Devices" and consist of everything connected to

Teletypes are standard pieces of peripheral hardware. Depending on the type used, teletypes can input/output information at various speeds.

### Printers

Printers enable your computer to give information in hard copy form. Often printers are merely teletypes, but others include chain printers, drum printers, and electrostatic printers. For the most part, the cost of the printer depends on the speed at which it can print.

### Video Terminals

Video terminals are used when a hard copy is not necessary. The most common of these resemble television screens and use a cathode-ray tube (CRT). These terminals are the ones generally used in an audiovisual operation for job entry, job tracking, accounting, etc. Some specialized types allow the user to "draw" graphics.

### Modems

Modems are the primary means of data communications along communication links. These links are generally telephone lines that are either "conditioned" to eliminate noise sources or unconditioned. Modems allow computers at remote locations a way to directly communicate with one another. For example, a computer located at an AV detachment can be directly linked over conventional telephone lines with a master computer at the AV headquarters.

### Interfacers

Interfacers are the little black boxes that allow you to connect a computer to almost anything you can imagine. The only limitation is that whatever you connect has to be capable of receiving and sending binary information.

tions, not to discuss the intricacies of circuitry. Although you don't need to understand all the minute specifics involved in how computers work, you do need to understand why one design is better or worse for your application.

First of all, there is a basic difference between analog and binary computers. The analog method was the first computer design and it uses voltages to represent numerical values. All computations and calculations are based on the principle that voltages remain constant. The problem is, they don't. Voltages "age" or change characteristics over time. So the cumulative value of added volts also changes over time. And what resulted in 3.625 volts one week may total 3.630 volts the next. Not exactly the accuracy you'd expect from a computer.

Computers based on binary representation of numerical values avoid the problem of voltage characteristics and afford much tighter control over accuracy. In binary systems, all numbers are translated into a series of switches in a computer that are either "on" or "off." And since the switches can't vary like voltage can, the problem of "aging" is eliminated. Again, the point here is not that you be able to work equations in binary form, but that you understand that a computer working equations in binary will always come up with the same answer.

"But," you may say, "computers don't just work equations, they work in words to answer my questions, to tell me information." That's not entirely true. What you see on a computer printout or hear on a computer programmed for audio output may indeed be words, but that's due to the way the system is programmed to respond. Computers can be programmed to interact with the user in a form that is most suitable and convenient for the user.

There is, among computer users, the term *gigo*—which means "garbage in, garbage out." Computers can only put out what has, in some form or another, been put in. If the input (program or raw data) is "garbage," then the result is also "garbage." Computer success depends on successful programming. And for a successful program, you should consult with a how they differ, and which would work best for you. As you read over the descriptions that follow, consider how each operating scheme might—or might not—work in your AV operation.

## REAL-TIME OPERATIONS

Real-time operations are the responses of the system to events as they take place in real time. Once an event takes place or instruction is given, the computer acknowledges, processes, and returns a result in the time it actually takes to complete the real-time operation. The speedometer of a car is a real-time "computer."

## BATCH PROCESSING

Batch processing is the alternative to real-time operations. In batch jobs, the computer carries out a standard set of commands in a predefined sequence. Once a batch starts, the computer schedules the completion according to its established priorities, then reports the results. Because batch processing generally takes longer than real-time operation, be wary of assigning timely or urgent jobs to a batch processing operation.

## INTERACTIVE COMMUNICATION

Most of the newer computer systems use *interactive communication*. This technique allows the user to communicate with the system and receive an immediate response (when used in real-time systems). Often these systems are programmed so that the user is told by the computer exactly how to use the system. The computer tells the user what information it needs and what procedure to follow, then acts upon the request.

The final area of computer operation which most people find mystifying is "how can computers do so many things at once?" The truth is, they can't and they don't. Computers can only

## MULTIPROGRAMMING

Multiprogramming or multitasking interrupt driven programming is the name for programming that allows computers to start and stop in the middle of things. A significant advantage of this type of computer operation is efficient utilization of the system. It doesn't have to wait to complete one task before beginning another.

You can see how important this type of programming is when you consider how a computer might operate a package printer. Without multiprogramming, it would have to wait for each step to be completed before moving on to the next. With multiprogramming, it starts the paper moving, then starts the lens deck moving, then goes back and stops the paper, adjusts the filters, goes back and stops the lens deck, and so on. With multiprogramming the computer is faster, more efficient, and more productive.

## COMPUTERS IN AUDIOVISUAL FACILITIES

For a specific example of how a computer can work in and for an AV operation, let's look at how Bremson Data Systems applied computer technology to the photographic industry.

Before computer logic could be fully implemented in the photographic printing process, the characteristics of color had to be quantified, put into precise mathematical formulas. Also, the qualities of lenses, filters, papers, chemicals, and all other photographic materials needed to be expressed in numerical quantities—because computer input has to be absolutely correct before the output can be.

Then, both the administrative and photographic ends of the color lab had to be analyzed, quantified, and distilled for a precise computer program. And that program had to be flexible enough to allow each lab the option to individualize certain areas; for example, to add their own package definitions.

Special interfaces were designed to link the various types of machinery (analyzers, printers, correction stations, etc.) and the various

The system, once fully installed, can literally handle everything in a photographic lab from job order entry through the actual printing to final delivery.

It controls everything by applying the same basic principles outlined above. It transmits data in binary form. It interacts with the operators. It employs multitasking. It breaks tasks down to their simplest components. These functions are accomplished in moments.

The same is true of the way Bremson Data Systems applied computer technology to individual photographic printers. With a single printer controller, Bremson has made computer technology, efficiency, and productivity available at the single printer level.

## COMPUTER COST

Computers and computer technology have gone down in cost dramatically over the years. And not only have the dollar figures dropped, the utilitarian value of computers has skyrocketed. Today's generation of computers are many times less expensive, a fraction of the size, and vastly superior in operation to the computers of the mid-60s.

But, despite the fact that computers have very attractive payback periods, they do require a rather substantial outlay of funds initially. However, the price tag on a computer system is not the true price you pay.

When looking at computer costs, you should examine the real cost of operating *without* the computer as well as with it. No information system is free. Look at your present way of doing things. Consider waste in time and materials, inefficiency, productivity, quality of service, access to information, errors, personnel required, training, turnover—everything connected with your operation. And set a dollar figure on as many items as possible.

After you've calculated how much it costs you to operate without a computer system, take another look at the cost of a computer system. Chances are you'll discover you can't afford to be without a computer!

*Rockester, NY 14650.*

Today's computers can help you produce useful and attractive graphic images quickly and economically. Companies selling equipment for making computer graphics emphasize that you don't have to be a computer whiz or an artist to make colorful, professional slides with computers and digital or color graphic film recorders. And no other image medium can surpass the brightness and image quality of 35mm slides for putting those computer graphic images on the screen.

A computer is used to create an electronic design onto a video monitor. The design corresponds to the colors, words, and lines you want in the finished color slide. You enter instructions with a typewriter-style keyboard or a digitizer tablet ("electronic sketch pad"), and the computer's data processing circuits convert your input to a color image on a video screen. Using this display, you can adjust the design until you have what you want. When it's correct, a film recorder (camera) photographs the image onto slide film.

The film recorder can produce slides that are considerably better than you could get by photographing the color video screen with a regular 35mm camera. First, the film recorder has a special high-resolution cathode-ray tube (CRT) with an extra-sharp image. Second, the face of this special tube is much flatter than a standard television tube, thus avoiding the distortion and unsharpness generally encountered when curved subject matter is photographed. And, third, for optimum sharpness and color rendition, the film recorder does not photograph a color image directly. (The normal color TV image is broken up into tiny dots of blue, green, and red phosphors, and the phosphors' color characteristics may not match the film.) Instead, the film recorder photographs a series of three black and white images from the CRT to make each slide, triple-exposing them onto each frame (In computer jargon these points are called "pixels," for picture elements.) Using a great many, very small pixels produces high-resolution images: sharp and detailed, with smooth edges on lines and lettering. Fewer, larger pixels give less detail and cause the blocky appearance commonly encountered with the less expensive video games or home computers.

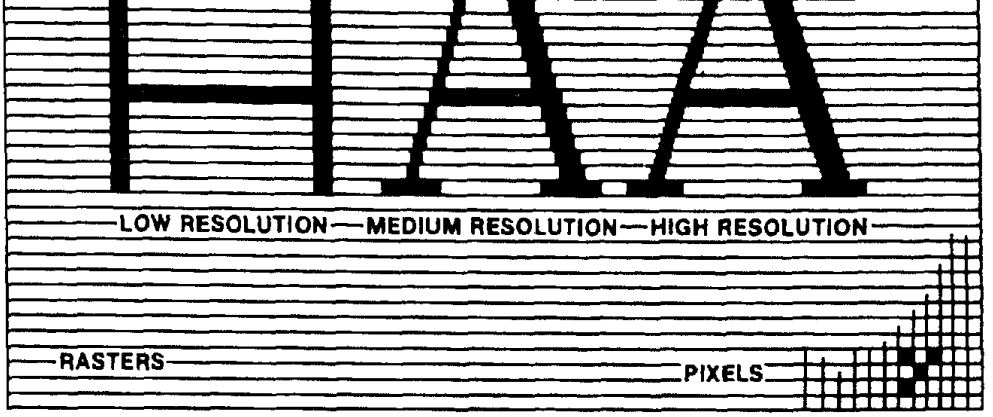
Computer graphics can be used to make slides of pie charts, bar charts, line graphs, area on strata graphs, etc. You can also produce title slides and dimension slides.

Older methods of producing 35mm slides incorporating these designs are costly and time-consuming. They require all handwork; every slide must first be drawn by an illustrator and then photographed. What's more, any corrections or changes require that the artwork be redone at a cost of time and money. With computer graphics, only the variable or changes have to be entered each time a modification to the original design is made.

There are at least three ways to obtain computer-generated slides:

- Buy or lease a complete system, including the film recorder (camera).
- Buy or lease a terminal only and use someone else's film recorder and/or large computer.
- Find a supplier who offers computer-made slides.

Each approach has advantages and disadvantages. The best choice for a given situation will depend on factors such as the number of slides you need per year, what kinds of slides you use (text, simple charts, complex graphs), how quickly you need them, whether the information in them must be kept classified, and so on. Then, add in financial considerations: Can you afford to buy

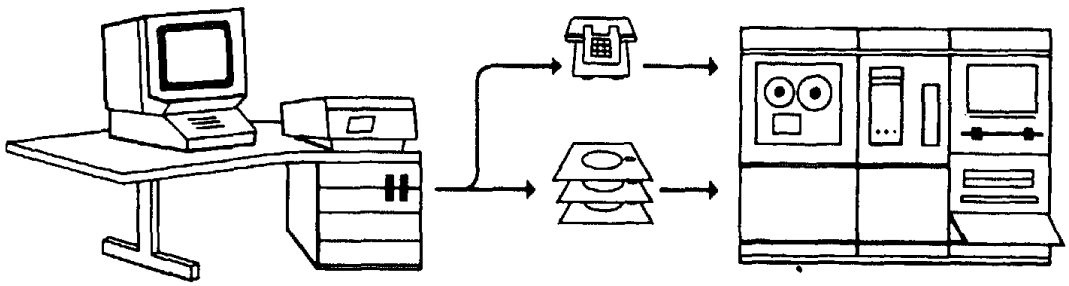



equipment out of your budget? Or would it be more practical to lease or rent it out of your operating budget? Would you be better off with a lower-cost system that is slower to operate, meaning labor costs per slide will be higher, or would you rather spend more and have a system that costs less in labor? The sum of all these factors will suggest what approach to computer slides is the most promising for your organization.

If you decide to buy or lease a computer system, you will need the computer itself (the keyboard), and perhaps a digitizer tablet, a display screen or monitor, a disk drive, and, of course, the film recorder. All in all, a high-resolution computer slide system may be priced in the $100,000 to $500,000 range when purchased outright and considerably less, but still quite expensive, when leased.

If it isn't essential for your activity to have its own film recorder, considerable expense can be saved by buying or leasing only a terminal—that is, the keyboard, CRT display, and a minicomputer or microcomputer that does the work. With this capability, you send the slide design data to a production center, either by phone hookup or by sending a computer memory disk or tape. At the production center, the data will be run through a film recorder to make your final slides, which are then returned to you by mail.

For many AV productions, the most inexpensive way to get computer-generated slides is having them made by a commercial supplier. This means your slides will be made on high-resolution equipment, and it means slide quality will benefit from the latest equipment and programs.



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Prepared by the Naval Education and Training Program Development Center, Pensacola, Florida

Your NRCC contains a set of assignments and perforated answer sheets. The Rate Training Manual, Navy Photographer's Mate Module 4 NAVEDTRA 373-04-67-83, is your textbook for the NRCC. If an errata sheet comes with the NRCC, make all indicated changes or corrections. Do not change or correct the textbook or assignments in any other way.

## HOW TO COMPLETE THIS COURSE SUCCESSFULLY

Study the textbook pages given at the beginning of each assignment before trying to answer the items. Pay attention to tables and illustrations as they contain a lot of information. Making your own drawings can help you understand the subject matter. Also, read the learning objectives that precede the sets of items. The learning objectives and items are based on the subject matter or study material in the textbook. The objectives tell you what you should be able to do by studying assigned textual material and answering the items.

At this point you should be ready to answer the items in the assignment. Read each item carefully. Select the BEST ANSWER for each item, consulting your textbook when necessary. Be sure to select the BEST ANSWER from the subject matter in the textbook. You may discuss difficult points in the course with others. However, the answer you select must be your own. Remove a perforated answer sheet from the back of this text, write in the proper assignment number, and enter your answer for each item.

Your NRCC will be administered by your command or, in the case of small commands, by the Naval Education and Training Program Development Center. No matter who administers your course you can complete it successfully by earning a 3.2 for each assignment. The unit breakdown of the course, if any, is shown later under Naval Reserve Retirement Credit.

## WHEN YOUR COURSE IS ADMINISTERED BY LOCAL COMMAND

As soon as you have finished an assignment, submit the completed answer sheet to the officer designated to grade it. The graded answer sheet will not be returned to you.

If you are completing this NRCC to become eligible to take the fleetwide advancement examination, follow a schedule that will enable you to complete all assignments in time. Your schedule should call for the completion of at least one assignment per month.

Although you complete the course successfully, the Naval Education and Training Program Development Center will not issue you a letter of satisfactory completion. Your command will make an entry in your service record, giving you credit for your work.

## WHEN YOUR COURSE IS ADMINISTERED BY THE NAVAL EDUCATION AND TRAINING PROGRAM DEVELOPMENT CENTER

After finishing an assignment, go on to the next. Retain each completed answer sheet until you finish all the assignments in a unit (or in the course if it is not divided into units). Using the envelopes provided, mail your completed answer sheets to the Naval Education and Training Program Development Center where they will be graded and the score recorded. Make sure all blanks at the top of each answer sheet are filled in. Unless you furnish all the information required, it will be impossible to give you credit for your work. The graded answer sheets will not be returned.

The Naval Education and Training Program Development Center will issue a letter of satisfactory completion to certify successful completion of the course (or a creditable unit of the course). To receive a course-completion letter, follow the directions given on the course-completion form in the back of this NRCC.

You may keep the textbook and assignments for this course. Return them only in the event you disenroll from the course or otherwise fail to complete the course. Directions for returning the textbook and assignments are given on the book-return form in the back of this NRCC.

your rating. The sources of questions in your advancement examination are listed in the BIBLIOGRAPHY FOR ADVANCEMENT STUDY (NAVEDTRA 10052). For your convenience, the Occupational Standards and the sources of questions for your rating are combined in a single pamphlet for the series of examinations for each year. These OCCUPATIONAL STANDARDS AND BIBLIOGRAPHY SHEETS (called Bib Sheets), are available from your ESO. Since your textbook and NRCC are among the sources listed in the bibliography, be sure to study both as you take the course. The qualifications for your rating may have changed since your course and textbook were printed, so refer to the latest edition of the Bib Sheets.

## NAVAL RESERVE RETIREMENT CREDIT

This course is evaluated at 12 Naval Reserve retirement points. These points are creditable to personnel eligible to receive them under current directives governing retirement of Naval Reserve personnel. Points will be credited upon satisfactory completion of the entire course.

and directing the work of a small crew to produce audiovisual productions

- Writing scripts
- Constructing and using storyboards
- Editing slide, motion picture, and TV presentations
- Staging media presentations
- Techniques of photographic process quality assurance to ensure a quality visual product
- Recognizing trends in control charts and taking action to bring and/or keep photographic processes in control
- The various types of aerial photographic missions and the advantages of proper mission planning
- Altitude, camera lens focal length, time interval, and aircraft speed necessary for a photographic reconnaissance flightcrew to successfully accomplish tactical air photographic reconnaissance missions
- The senior PH's responsibility for processing reconnaissance film
- The types of specialized photography senior PH's may be required to either perform, supervise, or teach to photographic and nonphotographic personnel.

While working on this correspondence course, you may refer freely to the text. You may seek advice and instruction from others on problems arising in the course, but the solutions submitted must be the result of your own work and decisions. You are prohibited from referring to or copying the solutions of others, or giving completed solutions to anyone else taking the same course.

(and the action required) through inspection of the samples given below.

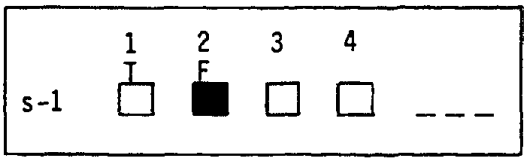
## MULTIPLE-CHOICE QUESTIONS

Each question contains several alternatives, one of which provides the best answer to the question. Select the best alternative, and blacken the appropriate box on the answer sheet.

SAMPLE

s-1. The first person to be appointed Secretary of Defense under the National Security Act of 1947 was
1. George Marshall
2. James Forrestal
3. Chester Nimitz
4. William Halsey

Indicate in this way on the answer sheet:



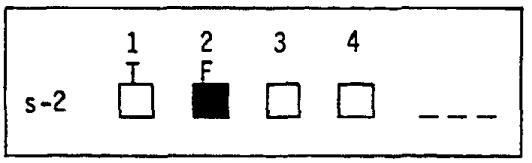

## TRUE-FALSE QUESTIONS

Mark each statement true or false as indicated below. If any part of the statement is false the statement is to be considered false. Make the decision, and blacken the appropriate box on the answer sheet.

SAMPLE

s-2. Any naval officer is authorized to correspond officially with any systems command of the Department of the Navy without his commanding officer's endorsement.

Indicate in this way on the answer sheet:




## MATCHING QUESTIONS

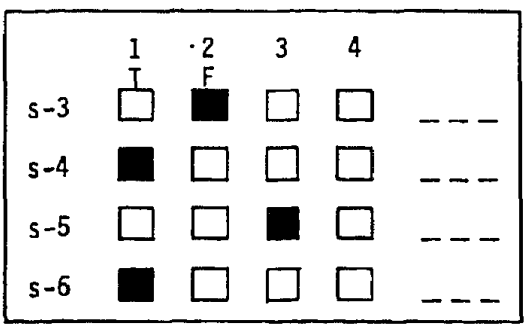
Each set of questions consists of two columns, each listing words, phrases or sentences. The task is to select the item in column B which is the best match for the item in column A that is being considered. Items in column B may be used once, more than once, or not at all. Specific instructions are given with each set of questions. Select the numbers identifying the answers and blacken the appropriate boxes on the answer sheet.

SAMPLE

In questions s-3 through s-6, match the name of the shipboard officer in column A by selecting from column B the name of the department in which the officer functions.

| A | B |
|---|---|
| s-3. Damage Control Assistant | 1. Operations Department |
| s-4. CIC Officer | 2. Engineering Department |
| s-5. Disbursing Officer | 3. Supply Department |
| s-6. Communications Officer | |

Indicate in this way on the answer sheet:



Textbook: Pages 1-1 through 1-34

In this course you will demonstrate that learning has taken place by correctly answering training items. The mere physical act of indicating a choice on an answer sheet is not in itself important; it is the mental achievement, in whatever form it may take, prior to the physical act that is important and toward which course learning objectives are directed. The selection of the correct choice for a course training item indicates that you have fulfilled, at least in part, the stated objective(s).

The accomplishment of certain objectives, for example, a physical act such as drafting a memo, cannot readily be determined by means of objective type course items; however, you can demonstrate by means of answers to training items that you have acquired the requisite knowledge to perform the physical act. The accomplishment of certain other learning objectives, for example, the mental acts of comparing, recognizing, evaluating, choosing, selecting, etc., may be readily demonstrated in a course by indicating the correct answers to training items.

The comprehensive objective for this course has already been given. It states the purpose of the course in terms of what you will be able to do as you complete the course.

The detailed objectives in each assignment state what you should accomplish as you progress through the course. They may appear singly or in clusters of closely related objectives, as appropriate; they are followed by items which will enable you to indicate your accomplishment.

All objectives in this course are learning objectives and items are teaching items. They point out important things, they assist in learning, and they should enable you to do a better job for the Navy.

This self-study course is only one part of the total Navy training program; by its very nature it can take you only part of the way to a training goal. Practical experience, schools, selected reading, and the desire to accomplish are also necessary to round out a fully meaningful training program.

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Learning Objective: Describe methods and techniques for planning and producing audiovisual productions. Be able to develop and arrange storyboard cards and write a script.

---

1-1. When planning an audiovisual production, you should consider which of the following factors about the audience ?
1. Their age
2. Their knowledge
3. Their social status
4. Each of the above

● Question 1-2 is to be judged True or False.

1-2. The person requesting an AV production is always in the best position to determine the audience's needs.

1-3. For which of the following reasons may AV productions be produced?
1. To entertain
2. To teach
3. To change an attitude
4. Each of the above

1-4. You should be able to determine the need for a presentation during which of the following phases of AV planning?
1. When the objective is written
2. When the outline is written
3. When the storyboard cards are assembled
4. When the script is reviewed

1-6. What MINIMUM number of people should be involved in storyboarding an AV production?
1. One
2. Two
3. Three
4. Four

1-7. Which of the following ideas for a motion picture film should be recorded on a storyboard planning card?
1. The location of the opening scene
2. A description of the opening scene
3. The colors of actor costumes in the opening scene
4. Each of the above

1-8. Which of the following types of information can be included in the production notes section of a storyboard card?
1. The person to contact at the scene location
2. The number of people in the scene
3. The type of camera to use
4. Each of the above

● Question 1-9 is to be judged True or False.

1-9. A storyboard card must show the complete dialogue for the scene or shot it represents.

1-10. Which of the following AV planning instruments serves as your plan for writing the script?
1. Storyboard
2. Outline
3. Objectives
4. Story treatmsnt

1-11. Which of the following AV documents describes the production in the greatest detail?
1. Storyboard
2. Story treatment
3. Script
4. Technical advisor's research material

3. Producer
4. Sound recorder

1-13. The chief part of a script is which of the following sections?
1. Scene locations
2. Lighting requirements
3. Action outline
4. Each of the above

1-14. The size of the videotape to be used in a TV production is stated in what section of the script?
1. Production treatment
2. Action outline
3. Shot breakdown
4. Each of the above

1-15. Which of the following parts of a script is NOT usually presented in story sequence order?
1. Production treatment
2. Action outline
3. Shot breakdown
4. Each of the above

● In answering question 1-16, refer to the example of the shot breakdown on pages 1-13 through 1-14 of the text.

1-16. Which of the following statements is correct?
1. Shots 7 and 21 through 23 can be shot after shots 28 through 30
2. Shots 7 and 21 through 23 can be shot before shots 28 through 30
3. Shots 54 through 62 can be shot after all the titles are shot
4. Each of the above

● Question 1-17 is to be judged True or False.

1-17. An AV production may have several climaxes.

1-18. A minimum of how many actors are needed for this production?
1. Five
2. Two
3. Three
4. Four

1-19. How many bikinis will the wardrobe department need to provide?
1. One
2. Two
3. Three
4. Four

1-20. At what time of day will the kidnapping occur?
1. Morning
2. Midmorning
3. Midafternoon
4. Evening

1-21. When you write the dialogue portion of a script, what is the MAXIMUM number of key points that should be included in a sentence?
1. One
2. Two
3. Three
4. Four

1-22. When you write the narration for a script, which of the following symbols should you use to indicate to the narrator that he should emphasize the point?
1. . . .
2. ═══
3. C
4. Each of the above

● Question 1-23 is to be judged True or False.

1-23. With regard to the narrative of a multi-image script, once a key point has been made it can be repeated in subsequent sentences.

1-24. The narration for a particular segment of a TV production will last 2 minutes. About what MINIMUM number of shots should the director use during this narration?
1. 10
2. 22
3. 33
4. 44
3. Music
4. Dialogue

1-26. Why is the selection of music for the end of an AV presentation an important consideration?
1. It "tells" the audience the presentation is over
2. It helps to relax the audience
3. It helps the audience to remember what they have seen
4. Both 2 and 3 above

1-27. In a script, what does the symbol C-2 indicate?
1. Multi-image visual
2. Second visual
3. Repeat the narration for the visual
4. Show the visual twice

● In answering question 1-28, refer to the script on pages 1-19 and 1-20 of the text.

1-28. What was the approximate MAXIMUM screen time for the part of the script shown in the text?
1. 1 minute
2. 2 minutes
3. 1.5 minutes
4. 2.5 minutes

1-29. The type of AV presentation to be used is determined at which of the following times?
1. Before the objectives are formulated
2. After assessing the type of audience
3. Before the script is started
4. All of the above

1-30. Which of the following AV presentation methods may be appropriate for use aboard ships of the U.S. Navy?
1. Multi-image
2. Videotape
3. Motion picture
4. Each of the above

1-31. When you select the method for presenting information through audiovisual means, which of the following considerations is of prime importance?
1. The equipment available
2. The information to be presented
3. The skill of the production crew
4. The cost of the production

3. Facilities
4. Each of the above

1-33. A simple series of B&W prints can be used effectively to inform all but which of the following audiences?
1. A small group of technical specialists
2. A small group of individuals having different backgrounds
3. A small group of students specializing in AV products
4. Large groups

1-34. When we speak of slides "being flexible," we mean the slides meet what requirements?
1. They are not stiff and won't be easily damaged in the projector
2. They can be easily replaced
3. They pop in and out of focus in the projector
4. They can be bound in rigid plastic mounts

1-35. Which of the following AV medias is NOT an evolution of still pictures?
1. Motion picture
2. Multi-image
3. Videotape
4. Multi-media

● Question 1-36 is to be judged True or False.

1-36. According to the text, only video recordings are used with the closed-circuit TV systems aboard our Navy ships.

1-37. Generally speaking, when are "fades and dissolves" made for (a) motion pictures and (b) multi-image productions?
1. (a) When the film is printed
   (b) when the production is presented
2. (a) When the film is presented
   (b) when the production is duplicated
3. (a) When the film is presented
   (b) when the production is presented

1-38. In a multi-image production, what size slides are most often used?
1. 40mm x 40mm
2. 2 x 2 inches
3. 35mm x 35mm

1-40. If you have received an Audiovisual Activity Job Order to produce a slide presentation you need not analyze the needs of the audience during the planning process.

1-41. Refer to the steps below and select the proper arrangement of the steps when you plan a slide presentation?

A. Analyze the audience
B. Define the objectives
C. Write the story treatment
D. Make an outline
E. Review your progress
F. Write the script
G. Prepare the storyboard
H. Plan the slides

1. A, G, F, E, D, H
2. B, A, C, D, F, E, G, H
3. B, A, D, E, C, F
4. B, A, E, D, E, C

1-42. Artwork for a 40mm x 40mm slide should be prepared in what image format ratio?
1. 1:1
2. 1:2
3. 1:3
4. 1:4

1-43. Approximately what MAXIMUM number of words should you include on a title slide?
1. 8
2. 15
3. 36
4. 43

1-44. A slide with which of the following background "colors" will show the most defects when projected?
1. Brown
2. Black
3. White
4. Gray

1-45. Which of the following factors affects the readability of text slides?
1. Contrast
2. Color
3. Size
4. Each of the above

a slide presentation, you must adhere to the script requirements when you select usable slides.

1-47. Although not required by the script, you may incorporate support slides into a slide production.

1-48. What is the first step in planning an audiotape presentation?
1. Deciding on the tape quality
2. Making an outline
3. Writing the objectives
4. Finding a narrator

1-49. The infinitive has been split in which of the following sentences?
1. The first assignment is to plan an AV presentation
2. The PHAN was told to immediately load his camera
3. It is necessary to classify all objectives
4. It is important to meet the deadline set by PD

1-50. In which of the following sentences has the modifier been misplaced?
1. Looking for some film in the stockroom, he found a camera
2. Having finished shooting the scene, the photographer developed the film
3. Believing that the movie could be produced at a reasonable cost, the contractor accepted the script
4. Being adequately dry, I took the film from the hanger

1-51. Which of the following sentences has a dangling modifier?
1. Having completed the scene, the camera shutter closed
2. When he completed the scene, he closed the camera shutter
3. Having completed the scene, he closed the camera shutter
4. All of the above

1-52. Which of the following sentences has/have a squinting modifier?
1. Teachers rarely get rich
2. Rarely do people who teach get rich
3. Both 1 and 2 above
4. People who teach rarely get rich

each day
3. The photographer is reshooting the scene
4. The photographer assumes responsibility for the film

1-54. Which of the following sentences use(s) direct phrasing?
1. Shoot this scene
2. Open the camera shutter
3. Both 1 and 2 above
4. If you have time, will you please shoot this scene

1-55. The pronoun is NOT in agreement with the word or clause to which it refers in which of the following sentences?
1. When anyone makes an error, he should not deny it
2. Each photographer thinks their caption is the best
3. All photographers will be expected to present their finished photographers
4. Everybody should have his camera ready for shooting

1-56. Which of the following sentences do(es) NOT have agreement in construction?
1. The airman bought a gold-and-silver pen
2. The airman bought a gold- and silver pen
3. The airman bought a gold and silver pen
4. All of the above

1-57. Which of the following criteria is probably the MOST important when you select a speaker?
1. The speaker's knowledge of grammar
2. The speaker's ability to pronounce words
3. The speaker's voice
4. The speaker's use of body movement

3. One-fourth up the scale from your base
4. One-fourth down the scale from your treble

1-59. When narrating an AV production, you should change your voice pitch to accomplish which of the following?
1. Excite ths audience
2. Emphasize a point
3. Ask a question
4. Each of the above

1-60. Voice quality refers to what aspect of the voice?
1. Pitch
2. Volume
3. Tone

1-61. As a narrator, for which of the following reasons should you know the script?
1. It helps you control your voice volume
2. It allows you to control your breathing
3. It improves your voice quality
4. Each of the above

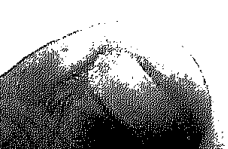
1-63. The theme from "A Summer Place" could be used in a movie about Navy ships.

1-64. Which of the following types of music is usually most appropriate for AV productions?
1. Rock
2. Classical
3. Semiclassical
4. Popular

1-65. You are tasked with producing 25 duplicate cassette audio recordings of a musical presentation. (a) At what ips rate should the original music be recorded; (b) what size tape should be used for the original recording; and (c) at what ips rate should the duplicate cassettes be played?
1. (a) 15 (b) 1/4 inch (c) 15
2. (a) 3.75 (b) cassette (c) 3.75
3. (a) 7.5 (b) cassette (c) 7.5
4. (a) 3.75 (b) 1/4 inch (c) 3.75

1-66. For highest quality sound reproduction, what thickness of audiotape should you use?
1. 1/2-mil
2. 1-mil
3. 1 1/2-mil





Audiovisual Productions

Textbook: Pages 1-35 through 1-51

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Learning Objective: Determine the methods and techniques of planning, directing, and producing effective audiovisual productions.

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2-1. Which method of audiotape editing is most desirable?
1. Electronic only
2. Mechanical only
3. A combination of 1 and 2 above

2-2. Mechanical audiotape editing should be limited to tapes with a maximum of how many recorded tracks?
1. One
2. Two
3. Three
4. Four

2-3. Which of the following audiotape recordings should NOT be mechanically or electronically edited?
1. A multitrack recording
2. An original recording
3. A cassette recording
4. An open reel recording

2-4. When splicing audiotape, at what angle should you make cuts?
1. 90°
2. 60°
3. 45°

● Questions 2-5 and 2-6 are to be judged True or False.

2-5. It is not always necessary to use a splicing block to cut audiotape.

2-6. When splicing 1-mil audiotape the splice joint must overlap 1-mil.

2-7. A synchronized slide/tape AV production may NOT always have which of the following elements?
1. Visual
2. Audio
3. Recorded slide change cues

2-8. Which of the following change cues is the best to use in a slide production?
1. A mechanical click sound
2. An electronic tone
3. A musical tone
4. An inaudible cue

2-9. Combining speech and music onto an audiotape is called sound
1. effects
2. tracking
3. two-tracking
4. mixing

2-10. On which side of an audiotape should a reference mark for the cue be made?
1. Oxide
2. Base
3. Either 1 or 2 above, depending on the type of tape used

● In answering question 2-11, refer to the following sentence.

"When the Japs (1) made their first bombing run on Marivales (2), most of us, being new at war (3), huddled togather under such cover as we could find (4)."

2-11. For a synchronized slide/tape presentation, at which point or points can a visual change be made?
1. 1 and 4 only
2. 2 and 3 only
3. 3 and 4 only
4. 1, 2, 3, or 4

2-12. Approximately what minimum spacing, in seconds, is used for slide change cues on an audiotape?
1. 1
2. 2
3. 3
4. 4

● Question 2-13 is to be judged True or False.

people comprise the main crew, picture production crews?
1. Nine
2. Two
3. Six
4. Four

2-15. Which member of a motion picture crew is called the "gaffer"?
1. Producer
2. Director
3. Head electrician
4. Second cameraman

2-16. On a motion picture production crew, what is the grip's function?
1. Handling equipment
2. Lighting the set
3. Directing camera movements
4. Operating the boom microphone

2-17. A Navy mopic production crew generally consists of about how many members?
1. One
2. Two
3. Three
4. Five

2-18. A "well-oiled" motion picture crew will probably have which of the following attributes?
1. Dedication
2. Enthusiasm
3. Dependability
4. Each of the above

2-19. Which of the following members of a studio motion picture production crew is usually in charge of the crew?
1. Director
2. Director of photography
3. Second cameraman
4. Producer

2-20. The title "director of photography," as applied to a member of a motion picture crew, is synonymous with what other title?
1. Director
2. First cameraman
3. Second cameraman
4. Producer
4. Chief electrician

2-22. Which of the following members of a movie crew generally operates the camera?
1. First cameraman
2. Assistant cameraman
3. Director of photography
4. Grip

2-23. Which of the following members of a movie crew is usually charged with making a record of all shots made?
1. Operating cameraman
2. First cameraman
3. Director
4. Grip

2-24. When working with a movie crew, a motion picture director should NOT exhibit which of the following characteristics?
1. Tyranny
2. Modesty
3. Tolerance
4. Sympathy

2-25. The production script should be studied by which of the following members of a motion picture production crew?
1. Actor
2. Grip
3. Gaffer
4. Each of the above

2-26. What is the measure of success of an AV presentation?
1. The speed with which the project is completed
2. The degree of audience participation generated by the production
3. The number of times the audience want to view it
4. The cost to effectiveness ratio of the production

for and (b) seeing for the audience?
1. (a) Director
   (b) director
2. (a) Camera operator
   (b) camera operator
3. (a) Director
   (b) camera operator
4. (a) Camera operator
   (b) director

2-28. "Audience placement" with regard to motion picture directing refers to the
1. apparent position of the audience in relation to the filmed action
2. apparent position of the audience in relation to the screen action
3. actual position of the audience in relation to the filmed action
4. actual position of the audience in relation to the screen action

2-29. In motion picture production, how many "audience placement" styles do we use?
1. One
2. Two
3. Three
4. Four

2-30. In directing a motion picture, what are the three modes of visual presentation you might use?
1. Participant, imaginary, and real
2. Point-of-view, subjective, and objective
3. Influence, interpretation, and personal
4. Actual, arbitrary, and relationship

2-31. When you do not want the motion picture audience to feel as if they are part of the filmed action, what style of audience placement should you use?
1. Imaginary
2. Point-of-view
3. Subjective
4. Objective

film?
1. The audience is part of the action taking place
2. The audience is not part of the action taking place
3. The audience is seeing the action through the "eyes" of the camera
4. The audience is in agreement with the action taking place

2-33. Actors must NOT look at the camera when the audience is in what placement mode?
1. Subjective
2. Objective
3. Point-of-view

2-34. The narrator of a TV panel discussion show looks directly at the camera when he addresses the viewers. What type of audience placement, if any, is being used?
1. Point-of-view
2. Objective
3. Subjective
4. None

2-35. What type of motion picture relies heavily on the subjective audience placement mode?
1. Semicontrolled
2. Documentary
3. Orientation

● Question 2-36 is to be judged True or False.

2-36. You are filming an interview where both the reporter and interviewee will be seen on camera. If you begin the interview in the subjective audience placement mode showing both people looking at the camera, you must use the subjective mode throughout the entire interview. However, if you begin the interview with an objective audience placement mode, you may at some time during the interview transit into a subjective mode.

are considered what type of audience placement?
1. Objective
2. Subjective
3. Point-of-view
4. Either 2 and 3 above, depending on the type of production

2-38. In your job as a director of motion pictures you must be concerned with the actor's eye angle to ensure a view of the actor's eyes
1. does not look directly at the camera
2. does not cause the impression that the actor is looking beyond the visible action
3. does not show too much white of the eyes which may cause them to appear "bug-eyed"
4. causes the audience to believe the actor's view is "pointing" to the location of an object

2-39. In what audience placement mode is actor eye angle probably of greatest importance?
1. Objective
2. Subjective
3. Point-of-view
4. Each of the above

2-40. A viewer of projected screen images will receive visual indications of his relative position to the viewed action through which of the following elements of photographic composition?
1. Image size
2. Camera angle
3. Camera height
4. Each of the above

2-41. As a motion picture director, how can you help the audience perceive depth in a screen image?
1. By logically placing reference objects in the scene.
2. By using the proper camera angles when filming events
3. By following the rules of good photographic composition
4. Each of the above

direction of travel of a moving subject, will cause the subject image to have the greatest apparent speed?
1. 360°
2. 180°
3. 90°
4. 45°

2-43. To film a tranquil scene you should direct the cameraman to use what POV?
1. Level-angle
2. High
3. Low

2-44. To prevent a doorway's parallel lines from converging at infinity, what audience POV should be maintained?
1. Level
2. Low
3. High

2-45. What audience POV usually shows a subject as being important?
1. Level
2. Low
3. High

2-46. What audience POV will decreass the apparent speed of a subject?
1. Level
2. Low
3. High

2-47. What type of motion picture shot is used to change the vertical viewpoint during the shooting of a scene?
1. Level
2. Moving angle
3. Decreasing height
4. Crane

2-48. What type of camera shot shows a compound view?
1. Angle-on-angle
2. Crane
3. Multiangle
4. Compound plane

2-49. What type of movie shot produces the greatest multidimensional illusion?
1. Point-of-view
2. Angle-on-angle
3. Level-angle
4. Dutch angle

Figure 2A.

- In answering question 2-50 refer to figure 2A.

2-50. What type of shot was used to record the scene?
1. Point-of-view
2. Angle-on-angle
3. Level-angle
4. Dutch angle

2-51. When a projected screen image is viewed what do we generally use as a horizontal reference?
1. The bottom edge of the image
2. The side edges of the image
3. The floor of the viewing room
4. The wall of the viewing room

2-52. What type of camera shot would probably best show the POV of a person who has overdosed on drugs?
1. Angle-on-angle
2. Point-of-view
3. High angle
4. Dutch angle

2-53. What is the second part of a motion picture film director's primary job?
1. Effective audience placement
2. Maintaining continuity
3. Knowing the technical aspects of the camera operator
4. Supervising the editors

- Question 2-54 is to be judged True or False.

2-54. As a motion picture director you must always present the filmed action in such a manner that the audience will not be confused.

2-55. "Position in time" with regard to motion pictures refers to
1. where the action took place
2. why the action took place
3. when the action took place
4. what action took place

2-56. Which of the following principles is basic to continuity?
1. Show changes in direction
2. Show changes in location
3. Promptly show evidence of any action change in the following scenes
4. Each of the above

2-57. Which of the following filming faults usually result(s) in audience confusion as to the location of subsequent scenes?
1. Excessive camera angle charges
2. Charging fps rate
3. Inserting a cutaway
4. Loss of leading line composition

helps an audience remember the location of a scene?
1. LS
2. MS
3. CU

2-59. What screen direction should be used to show a movie subject traveling from Jacksonville, Florida to Pensacola, Florida?
1. Top to bottom
2. Bottom to top
3. Right to left
4. Left to right

● Questions 2-60 through 2-63 are to be judged True or False.

2-60. Most motion picture special effects are produced in the laboratory, not in the camera.

2-61. A fade-out is usually produced in the camera.

2-62. A fade-in is usually produced in the camera.

2-63. A dissolve is usually produced in the camera.

2-64. When you are making double exposures of an actress talking to her "twin" image, which of the following background "colors" is generally best?
1. Blue
2. White
3. Black
4. Gray

2-65. Where on a motion picture camera is the matte box installed?
1. In the film chamber
2. On top of the film magazine
3. Between the camera base and the tripod
4. On the lens

camera wipe?
1. It is difficult to make
2. The wipe is shaky
3. The projection screen is blank for a time
4. Each of the above

2-67. To make a camera wipe of a subject moving left to right you move a cardboard over the camera lens from top to bottom. You then stop the camera. After restarting the camera, in what direction should you move the cardboard to wipe the next scene on?
1. Top to bottom
2. Bottom to top
3. Right to left
4. Left to right

● Question 2-68 is to be judged True or False.

2-68. The use of animation and models of subjects will always result in inferior quality motion pictures and should be avoided except when the script calls for destruction of the subject.

2-69. You edit a motion picture to show four scenes of a tree. In the first scene the tree is bare. Scene two shows the tree with snow on it. The third scene shows the tree with tiny buds starting to grow. The last scene shows it fully leaved. What type of shots are these?
1. Seasonal
2. Buildup
3. Transition
4. Special effect

Audiovisual Productions

Textbook: Pages 1-51 through 1-69

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Learning Objective: Use methods and techniques of planning, directing, and producing audiovisual presentations and edit motion picture films.

3-1. The distance between modulations on an audiotape represents what characteristic of sound?
1. Frequency
2. Linear distance
3. Surface speed
4. Physical structure

3-2. Which of the following definitions best describes matched sound recording and playback medium velocity?
1. Frequency
2. Synchronization
3. Modulation
4. Consistent

3-3. When the linear speed of the sound reproducing surface is the same as the linear speed of the sound recording surface the recording is said to be in
1. fixed speed
2. consistent drive
3. synchronization
4. frequency tolerance range

3-4. How many modulations of 10,000 cycle per second vibration sound will be recorded on 1 inch of audiotape that has a surface speed of 7.5 ips?
1. 1333
2. 2444
3. 3111
4. 4222

3-5. To produce a standard motion picture, the speed of the sound recording surface of the film must be
1. 7.2 ips
2. 16.0 ips
3. 3.3 ips
4. 5.4 ips

● Question 3-6 is to be judged True or False.

3-6. The sound track portion of a movie film for a given frame is ahead of the picture frame.

3-7. For precise synchronization, the optical sound for a given frame of movie film should be how far ahead of the picture frame?
1. 22 frames
2. 24 frames
3. 26 frames
4. 28 frames

3-8. For precise synchronization, the magnetic sound for a given frame of movie film should be how far ahead of the picture frame?
1. 22 frames
2. 24 frames
3. 26 frames
4. 28 frames

3-9. The optical sound for motion picture film should be how many inches ahead of the frame to which the sound corresponds?
1. 7.8 inches
2. 6.8 inches
3. 5.8 inches
4. 4.8 inches

3-10. The magnetic sound for a motion picture film should be how many inches ahead of the frame to which the sound corresponds?
1. 8.2 inches
2. 8.4 inches
3. 8.6 inches
4. 8.8 inches

motion picture film, what (a) minimum and (b) maximum sound-lead is permissible?

1. (a) 22 frames (b) 24 frames
2. (a) 24 frames (b) 28 frames
3. (a) 26 frames (b) 30 frames
4. (a) 28 frames (b) 32 frames

3-12. For a synchronized magnetic sound motion picture, what (a) minimum and (b) maximum sound-advance is permissible?

1. (a) 22 frames (b) 26 frames
2. (a) 24 frames (b) 28 frames
3. (a) 26 frames (b) 30 frames
4. (a) 28 frames (b) 32 frames

3-13. What are the two primary methods of recording sound for motion pictures?

1. Variable-area and variable-density
2. Variable-optical and variable-magnetic
3. Synchronized and nonsynchronized
4. Optical and magnetic

3-14. The best quality sound fidelity is produced by what motion picture sound recording method?

1. Magnetic
2. Optical
3. Variable-density
4. Variable-area

● Questions 3-15 and 3-16 are to be judged True or False.

3-15. Variable-density optical sound recording requires the most exacting photographic processing.

3-16. Variable-density optical sound recording results in a wide range of gray tone images.

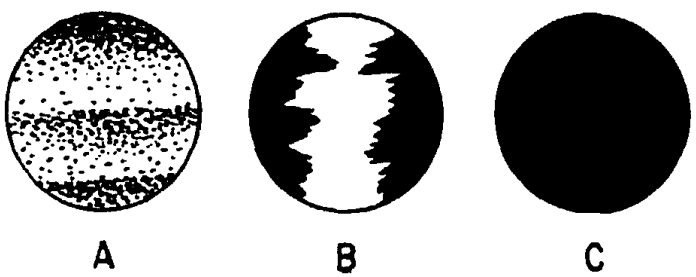


Figure 3A.--Areas of motion picture sound track.

● In answering questions 3-17 and 3-18, refer to figure 3A.

of motion picture variable-area optical sound track?

1. A
2. B
3. C

3-18. Which area will probably result in the most background noise due to overexposure?

1. A
2. B
3. C

● Questions 3-19 through 3-21 are to be judged True or False.

3-19. All motion picture films which have a sound track are produced with single-system sound recording.

3-20. All double-system sound recording is optical sound, whereas all single-system recording is magnetic sound.

3-21. A motion picture camera designed for single-system sound recording can be used for double-system sound recording, whereas a camera designed for double-system sound recording cannot be used for single-system recording.

3-22. What type of sound recording is generally used for a major motion picture production?

1. Variable-area
2. Magnetic
3. Single-system
4. Double-system

3-23. When are the sound track and pictures first joined together in a double-system sound motion picture production?

1. During film processing
2. During editing
3. When the composite print is made
4. When the film is projected for the first time

mark 26 frames ahead of the corresponding picture frame and cut straight across

2. Place the sound track clapstick mark 26 frames behind the corresponding picture frame and cut at a 45-degree angle
3. Place the sound track clapstick mark 26 frames ahead of the picture clapstick image and make two 45-degree angle cuts
4. Align the picture and sound track clapstick sync marks and make straight-across cuts

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In answering questions 3-25 through 3-28, select from column B the equipment used to accomplish the task listed in column A.

| | A. Tasks | B. Equipments |
|---|---|---|
| 3-25. | Cut the film | 1. Reader |
| 3-26. | View one film frame | 2. Motion viewer |
| | | 3. Gang synchronizer |
| 3-27. | Listen to sound | |
| | | 4. Splicer |
| 3-28. | Keep picture film and sound track film matched "frame for frame" | |

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3-29. How many basic pieces of equipment will you use to edit motion picture film?

1. One
2. Two
3. Three
4. Five

| | A. Types of Productions | B. Editing Functions |
|---|---|---|
| 3-30. | Documentary | 1. Make a meaningful presentation of footage provided |
| 3-31. | Controlled action | |
| 3-32. | Uncontrolled action | 2. Interpret a script |
| | | 3. Produce a logical movie of an actual event |

---

● Question 3-33 is to be judged True or False.

3-33. Because a controlled action film is scripted in detail, the editor has very little control over the assembly of the individual film parts.

3-34. To determine what scenes might be available to assembly a semicontrolled action film of a military training exercise, an editor would MOST probably refer to which, if any, of the following documents?

1. Script
2. Story treatment
3. Shooting outline
4. None of the above

● Question 3-35 and 3-36 are to be judged True or False.

3-35. The editor of semicontrolled and uncontrolled action documentary films should be given the liberty to assemble the film in such a way that emphasis is placed on specific factors.

3-36. The editor of semicontrolled and uncontrolled action films has as a primary objective the assembly of the footage available to make an effective film which has no psychological effect on the audience. Therefore, the editor does not employ any artistic or creative talent, only mechanical ability.

3-38. In theory, every shot in which of the following types of films can be edited?
1. Uncontrolled action
2. Semicontrolled action
3. Controlled action

3-39. In the camera footage available of a controlled action movie there is footage which is not a fact of the subject of the film but which supports the objectives of the film. What term is generally applied to this type of footage?
1. Continuity bridging footage
2. Generic footage
3. Editability footage
4. Protection footage

3-40. Which of the following transition shots best describe(s) protection footage?
1. Cut-in
2. Cutaway
3. Both 1 and 2 above
4. Generic shot

3-41. As a motion picture cameraman, you should shoot protection footage for which of the following types of movie?
1. Controlled
2. Semicontrolled
3. Uncontrolled
4. Each of the above

3-42. Shooting individual motion picture scenes so they are editable with previous and subsequent scenes best defines which of the following filming practices?
1. Maintaining continuity
2. Key scene preservation
3. Editing in the camera
4. Protection footage shooting

● Question 3-43 is to be judged True or False.

3-43. When a "professional" motion picture cameraman edits in the camera there is no need for further editing of the film.

C. When a cameraman edits in the camera, the resulting film will always have good continuity even without further editing.

3-44. Select the alternative which correctly identifies statements A, B, and C as being either true or false.
1. A, B, and C are false
2. A, B, and C are true
3. A and B are true, C is false
4. A and B are false, C is true

3-45. The art of editing a motion picture so it logically presents a story from beginning to end requires that the editor maintain which of the following motion picture aspects?
1. Continuity
2. Sequences
3. Key scenes
4. Believability

3-46. Extracting and refining motion picture continuity from available footage is best defined as
1. editing
2. sequencing
3. key scenes
4. orderly structuring

---

In answering questions 3-47 through 3-50, match the written story element in column B to the motion picture story element in column A.

| A. Motion Picture Story Elements | B. Written Story Elements |
|---|---|
| 3-47. Entire film | 1. Several chapters |
| 3-48. Single shot | 2. A word |
| 3-49. Shot progression | 3. A page |
| 3-50. Shot sequence | 4. A chapter |

3. A shot
4. A shot sequence

3-52. Several complete shot sequences of a motion picture film are referred to as
1. filmic devices
2. sequenced groups
3. picture elements
4. modules

3-53. What are the typical motion picture shots that make up a shot sequence?
1. ELS, LS, MS, MCU, CU, ECU
2. ELS, LS, MS, CU only
3. LS, MS, CU only
4. LS, MS, MCU, CU only

3-54. What should be your first step in the editing process for an uncontrolled action film?
1. Determining how much film is available for editing
2. Limiting the amount of film to be edited by discarding excessive footage
3. Defining what information the film is to communicate
4. Previewing the camera footage and identifying processing faults

3-55. During what step in motion picture editing should you first view the camera footage?
1. First
2. Second
3. Third
4. Fourth

3-56. Which of the following types of films is normally previewed on a projector prior to film cutting?
1. Composite print
2. Release print
3. Camera original
4. Workprint

3-57. A motion viewer should be cleaned after how many feet of film has passed through it?
1. 1000
2. 2000
3. 3000
4. 4000

3-58. What is considered "green" film?
1. Unexposed raw stock
2. Exposed unprocessed film
3. Newly processed film
4. Film which has a high emulsion content

1. Planning
2. Workprint
3. Scene-logging
4. Breaking-down

3-60. What equipment should be used to conduct the planning scan of a workprint?
1. Motion viewer
2. Projector
3. Gang synchronizer
4. Film reader

3-61. What is the primary reason for conducting the planning scan of a workprint?
1. To check for editable footage
2. To ascertain the communicative objective of the film
3. To evaluate the quality of the photography
4. Each of the above

● Question 3-62 is to be judged True or False.

3-62. Most good film editors, because of the specialized nature of their work, are impatient craftsmen.

3-63. What document is prepared during the planning scan of a motion picture workprint?
1. The shot log
2. The smooth script
3. The editing content flow guide
4. The shot-progression sequence-continuity control log

3-64. The editor's written statement describing the film, together with a list of shot sequences, is called the
1. script
2. film treatment
3. visual outline
4. editing treatment

● Question 3-65 is to be judged True or False.

3-65. The editor always writes the editing treatment statement.

3-66. The first workprints from processed camera original motion picture film are called by what terms?
1. Rushes only
2. Dailies only
3. Rushes or dailies

● Question 3-67 is to be judged True or False.

3-67. Original camera motion picture film is cut only after the first dailies are made.

3-68. What is the primary purpose of the first assembly of a motion picture film?

1. To put all scenes and shots in proper sequence
2. To determine the length, in feet, of the first cut
3. To edit out all excess footage
4. To record film edge numbers

3-69. To determine the proper screen time for a given shot sequence, which of the following methods should you use?

1. Count the number of feet of film in the sequence, multiply that figure by 40, and divide the product by 24
2. Count the number of frames in the sequence and multiply by 40 only
3. Project the sequence and make a subjective judgment
4. Project the sequence and make an objective judgment

Audiovisual Productions

Textbook: Pages 1-69 through 1-109

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Learning Objective: Use professional audiovisual techniques and methods to produce properly planned, scripted, and edited cost-effective audiovisual communication productions and present media productions.

4-1. What are the two most important principles of film editing?
1. Continuity and visual impact
2. Continuity and dialogue
3. Cutting and splicing
4. Cutting and shot length

● Question 4-2 is to be judged True or False.

4-2. Motion picture film editing must always be based on the visual aspects of the film.

4-3. You have available footage of a subject shot from three different camera angles. You have cut and spliced the film so the subject action at the end of one shot matches the action at the head of the next shot. Which of the following editing principles have you followed?
1. Jump cut
2. Double action
3. Continuity
4. Sequencing

4-4. According to the text, a good place to make a cut when you edit film is where the action can be described as being
1. relaxed
2. exciting
3. negative
4. positive

4-5. The element in a hot film splicer reaches about what maximum temperature?
1. 25°C
2. 38°C
3. 50°C
4. 100°C

4-6. The drying time for film cement is approximately how many seconds in (a) a cold splicer and (b) a hot splicer?
1. (a) 8 (b) 10
2. (a) 18 (b) 11
3. (a) 20 (b) 15
4. (a) 25 (b) 15

4-7. A typical section of B&W movie film is made up of how many different layers?
1. One
2. Two
3. Three
4. Four

4-8. What are the two standard splice widths, in inches, for motion picture film?
1. 1/16 and 1/32
2. 1/10 and 1/16
3. 1/8 and 1/16
4. 1/5 and 1/10

4-9. What width, in inches, is (a) a negative film splice and (b) a positive film splice?
1. (a) 1/16 (b) 1/10
2. (a) 1/10 (b) 1/16
3. (a) 1/8 (b) 1/4
4. (a) 1/4 (b) 1/8

4-10. When repairing a motion picture film print for projection, what type of cement splice should you make?
1. Positive
2. Negative
3. Either 1 or 2 above, depending on the type of film

film splice?
1. Snap the film
2. Gently try to pull the film apart
3. Use your fingernail and try to separate the two film ends
4. Flex the film in a rolling U-shape

4-12. You have repaired, by cement splicing, a movie film which has a magnetic sound track. In subsequent projections of the film a "popping" noise is heard at each splice. What is the probable cause of this popping noise?
1. The splicer was magnetized
2. The splicer was demagnetized
3. Excessive cement is on the film base
4. Insufficient splicer block pressure was used

4-13. What type of solvent, if any, should you use to remove dried film cement from a splicer?
1. Alcohol
2. Film cement
3. Water
4. None

4-14. What term describes the editing process of matching original camera motion picture film to the workprint?
1. Synchronizing
2. Positive forming
3. Film sequencing
4. Negative cutting

4-15. The edge numbers on motion picture film become visible when the film undergoes (a) what process, and (b) when what film or print is made?
1. (a) Projection
   (b) camera original film only
2. (a) Exposure
   (b) workprint only
3. (a) Projection
   (b) release print
4. (a) Processing
   (b) camera original film and workprint

● Question 4-16 is to be judged True or False.

4-16. During negative cutting you need to match only the edge numbers of the workprint to the camera original film edge numbers to assembly a properly edited film.

used in the production of professional motion pictures?
1. Double-roll
2. Single-roll
3. Either 1 or 2 above, depending on the type of quality of film used

● Question 4-18 is to be judged True or False.

4-18. In checkerboard editing the A-roll contains camera original film and the B-roll contains opaque leader.

4-19. When you print double-roll negative cut film, how many times through the printer are (a) the A and B rolls passed, and (b) the print stock passed?
1. (a) Once only (b) once only
2. (a) Twice (b) twice
3. (a) Once only (b) twice
4. (a) Twice (b) once only

4-20. On what medium are most nonlive TV shows recorded?
1. Videotape
2. Audiotape
3. Motion picture film

4-21. In the Navy, what type of videotape equipment do we generally use?
1. 2-inch helical scan
2. 3/4-inch transverse scan
3. 2-inch transverse scan
4. 3/4-inch helical scan

4-22. In TV production the term "sequential shooting" refers to
1. shooting all scenes in sequential order
2. using one camera nonstop to record all scenes
3. using two or more cameras nonstop to record the action
4. being able to direct all single camera shots with the video mixer

4-23. When you use the nonsequential shooting method to record a TV show, how many seconds of recording should (a) precede and (b) follow the desired taped action?
1. (a) 5 (b) 5
2. (a) 5 (b) 10
3. (a) 10 (b) 5
4. (a) 10 (b) 10

4-24. All videotape editing is done electronically.

4-25. The process of transferring recorded scenes from one videotape to another is referred to by what term?
1. Programming
2. Inserting
3. Switching
4. Roughing

4-26. What type of audiovisual production offers the greatest challenge to your artistic ability?
1. Television
2. Motion picture
3. Synchronized slide/sound
4. Multi-image

4-27. You may be able to justify the cost of producing a multi-image presentation on the basis of what aspect(s) of the medium?
1. Its uniqueness of presentation
2. Its emotional appeal to the audience
3. Its impact on the audience
4. All of the above

● Question 4-28 is to be judged True or False.

4-28. The combination of still and motion images can be used only in multi-media and not in multi-image productions.

4-29. What aspect of a multi-image show is most significant in setting the pace of the show?
1. Music
2. Narration
3. Visual

4-30. What type of AV presentation relies heavily on recording "real-time" sound?
1. Instructional
2. Controlled action
3. Documentary
4. Informative

4-31. What image ratio is generally considered most appropriate for most multi-image presentations?

1. 1:1
2. 2:1
3. 3:1
4. 4:1

off in rapid succession
2. By varying the electrical power to two or more projector lamps
3. By using a single projector with ultra-rapid slide change
4. By using two or more projectors with ultra-rapid slide change

4-33. Which of the following sizes slides is suitable for multi-image productions?
1. 40mm x 40mm
2. 2x2 inch
3. 35mm
4. Each of the above

4-34. What is the size of the projectable image of a 35mm standard slide?
1. 23mm x 34mm
2. 24mm x 36.5mm
3. 35mm x 35mm
4. 40mm x 40mm

4-35. A standard 35mm slide has what image ratio?
1. 1:2
2. 2:2
3. 2:3
4. 2:4

4-36. The image ratio of a standard 35mm slide is which of the following ratios?
1. 1.5:1
2. 1:2
3. 1:3
4. 1.5:2.5

4-37. When four 35mm standard slide images are projected side by side on a screen, what will be the resulting image ratio?
1. 4.0:0.5
2. 4.0:1.0
3. 4.5:1.0
4. 6.0:1.0

4-38. Before beginning work on any AV production, you should consult what OPNAV Instruction?
1. 3500.6
2. 5290.1
3. 5510.1
4. 10700.1

minimum, the good viewing area should be how many square feet?

1. 120
2. 144
3. 220
4. 244

4-40. What type of movie screen is capable of providing the brightest image?

1. Matte
2. High-gain
3. Lentricular
4. Beaded

(a) the minimum, and (b) the maximum recommended audience distance from the screen?

1. (a) 8 feet (b) 4
2. (a) 41 feet (b) 6
3. (a) 48 feet (b) 6
4. (a) 62 feet (b) 4

Textbook: Pages 2-1 through 2-27

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Learning Objective: Recognize the principles, uses, and advantages of sensitometry in quality assurance.

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● Question 5-1 is to be judged True or False.

5-1. Once established, photographic quality standards must be inflexible.

5-2. The object of quality assurance in photography is to
1. reduce the time required for turning out a photographic product
2. test photographic sensitized materials
3. ensure maximum use of personnel and materials
4. ensure that the final photographic product is always of high quality

5-3. The quality of a photographic product depends upon three factors and their variables. What are these factors?
1. Human, manufacturer of the material(s) used, mechanical
2. Chemical, human, mechanical
3. Chemical, human, lab equipment provided
4. Equipment, personnel, time

5-4. Which of the following categories of personnel make(s) up the human element in a photographic QA program?
1. Photographers
2. Processing machine operators
3. Quality assurance technicians
4. Each of the above

5-5. When your QA program consists solely of visually comparing prints to one another, what type of program are you operating?
1. Subjective
2. Objective
3. Reference standard
4. Sensitometric

5-6. In a fully operational QA program, when should a camera defect be detected?
1. Before taking the picture
2. After processing but before drying the film
3. While the film is being printed
4. During print inspection

5-7. Which of the following factors contribute(s) the most to ensuring that high-quality photographs are produced?
1. Film storage
2. Film handling
3. Film exposure
4. Print exposure and processing

5-8. How can you be assured that the workers in your lab are following the manufacturers' instructions when they process film?
1. Monitor the process
2. Give them constant and personal supervision
3. Personally inspect each photograph produced

5-9. A quality assurance program should be built on a foundation of
1. subjectivity
2. reference standards
3. sensitometry
4. densitometry

● Question 5-10 is to be judged True or False.

5-10. Haphazard methods of photographic processing will NEVER produce quality photography.

5-11. Sensitometry provides the answers to processing problems in the form of
1. scientific opinion
2. personal judgment
3. numbers
4. subjective analysis

5-13. The photographic characteristics of light-sensitive materials are determined by applying which of the following?
1. Logarithms
2. Sensitometry
3. Densitometry
4. Chemical analysis

● Question 5-14 is to be judged True or False.

5-14. Sensitometry is the measurement of film sensitivity while densitometry is the measurement of film density. However, densitometry also refers to film sensitivity.

5-15. Which of the following sciences is the practical application of determining the photographic characteristics of light-sensitive materials?
1. Density
2. Densitometry
3. Sensitivity
4. Sensitometry

5-16. Before Navy photographers can be considered proficient in modern quality assurance techniques, they must have experience in
1. working with common logarithms
2. all areas of photographic production
3. the old trial and error methods of photography

5-17. As a photographer, in which of the following situations would you possibly use logarithms?
1. When densitometers are used in the production of positive viewing transparencies
2. When plotting characteristic curves
3. When determining density, gamma, and log E
4. All of the above

5-18. What is the common logarithm of 100,000?
1. 1
2. 2
3. 3
4. 5

5-20. The logarithm of exposure is used to plot characteristic curves for which of the following reasons?
1. Each increase in exposure is recorded as a disproportionate increase in log E
2. Each step on the log E axis represents a constant multiple of the value of the previous step
3. Each step on the log E axis is equal to a change in exposure of one f/stop
4. Each increase in exposure is recorded on the linear scale of the log E axis

5-21. Assume that you are measuring the density of a negative with a light source of 100 meter-candles and that the negative transmits 1 meter-candle. What is the transmission of the negative?
1. 1/5
2. 1/10
3. 1/25
4. 1/100

5-22. What is the opacity of a negative which transmits 20 percent of the light that falls on it?
1. 5
2. 2
3. 7
4. 10

5-23. If 26 mc of light are falling onto a film but only 7 mc of light are passed by the film, what percent of the light incident to the film is being transmitted?
1. 19
2. 27
3. 33
4. 41

5-24. What is the opacity of a negative which transmits 1 percent of the light that falls on it?
1. 100
2. 60
3. 40
4. 30

5-25. Density, the light-stopping ability of a photographic emulsion, is expressed as the
1. logarithm of transmission
2. logarithm of opacity
3. reciprocal of opacity
4. reciprocal of transmission

4. Density

5-27. Comparing the amount of exposure that is given to a sensitized emulsion to the amount of density that will result from that exposure is called
1. sensitivity evaluating
2. exposure analysis
3. time, temperature, gamma evaluation
4. sensitometric-densitometric testing

5-28. In studying the characteristics of a light-sensitive material, what is the instrument used to make a series of graded exposures on the material being tested?
1. Densitometer
2. Sensitometer
3. Exposure meter
4. Wedge spectrograph

5-29. In order to determine the response characteristics of an emulsion under conditions which simulate actual photography, a sensitometer's light source must meet which of the following conditions?
1. The color temperature of the light must be equivalent to that of the light used in practical photography
2. The time of exposure must be accurately controlled
3. The intensity of the light must be known
4. All of the above conditions must be met

5-30. Why are sensitometric strips used in photographic quality assurance?
1. They provide a convenient means of producing uniform, measurable sets of densities for test purposes
2. They provide a convenient means of producing uniform, measurable variations in gamma for test purposes
3. They provide complete information on the characteristics of photographic sensitized materials

2. The sensitized materials being tested will vary
3. It is necessary to ensure that the lamp is operating at the accepted color temperature of 5800°K
4. The current flowing through the filament controls the intensity and color quality of the light

5-32. Sensitometers are grouped into two classes. What are they?
1. Exposure modulator and spectral-scale sensitometers
2. Spectral analysis and variable intensity sensitometers
3. Time-scale and intensity-scale sensitometers
4. Class I (sheet film) and Class II (rollfilm) sensitometers

5-33. Why are intensity-scale sensitometers theoretically preferable to time-scale sensitometers?
1. Photographic materials in actual use are usually subjected to variations in intensity rather than variations in time
2. They compensate for the differences between time variations and intensity variations
3. The use of light-absorbing filters (step wedges) is not required
4. Time-scale sensitometers cannot accurately duplicate the action of modern camera shutters

5-34. When the degree of development for a given negative material is being determined, which of the following is NOT a consideration?
1. The spectral characteristics of the film
2. The size of the film
3. The length of time the developer is allowed to act
4. The activity or energy of the developer

5-35. To prevent uneven development in the processing of negative material, which of the following factors is involved?
1. Agitation
2. Temperature
3. Hydroquinone
4. Silver salts

1. To provide uniform, measurable sets of densities for test purposes
2. To read densities so that characteristic curves can be plotted
3. To provide complete information on the characteristics of photographic sensitized materials
4. To analyze photographic emulsions

5-37. Densitometers are used to measure the
1. light-passing ability of a negative
2. color sensitivity of a film
3. light-stopping ability of a negative
4. silver halide thickness in a negative

5-38. What other common term(s) can be used to describe a sensitometric curve?
1. H and D curves
2. Characteristic curves
3. Both 1 and 2 above

5-39. What is the lowest density reading plotted on the graph on page 2-10 of the text?
1. 0.12
2. 0.18
3. 0.22
4. 1.82

5-40. On page 2-10 of the text, what is (a) the log exposure and (b) the density of step 11 on the graph?
1. (a) 1.5 (b) 0.90
2. (a) 0.90 (b) 1.5
3. (a) 15.0 (b) 9.0
4. (a) 9.0 (b) 15.0

5-41. Which of the following factors may be derived from an analysis of a sensitometric curve of an emulsion?
1. Contrast
2. Effective speed
3. Useful exposure range
4. All of the above

5-42. Whenever there is an increase in development, how will the characteristic curve be affected?
1. The slope (gradient) of the straight line portion of the curve increases but all densities decrease
2. The slope (gradient) of the straight line portion of the curve and all densities on the straight line portion increase
3. The slope (gradient) of the straight line portion and the gamma remains the same
4. The gamma and all densities in the shoulder and toe portions of the curve are increased proportionally

1. 1 only
2. 1 and 2 only
3. 3 and 4 only
4. 1, 2, 3, and 4

5-44. What is the meaning of the term "threshold" when used in sensitometry?
1. The point at which a slight increase from base density is noted
2. The area which shows the base density plus any inherent fog density
3. The base density minus any inherent fog density
4. The point one step above the gross fog density

5-45. At what step on the graph on page 2-12 of the text does the toe section of the curve begin?
1. 1
2. 2
3. 3
4. 4

● Question 5-46 is to be judged True or False.

5-46. Satisfactory exposures can be made of subjects even though the shadow portion may fall in the toe area of the characteristic curve.

5-47. On which portion of the characteristic curve should the subject tones fall to ensure production of constant differences of density?
1. Toe
2. Shoulder
3. Threshold
4. Straight line

5-48. Referring to the graph on page 2-12 of the text, what log E exposure value corresponds to the inertia point?
1. 0.15
2. 0.49
3. 0.50
4. 4.5

5-49. Referring to the graph on page 2-18 of the text, how many exposure steps fall entirely within the shoulder of the curve?
1. One
2. Two
3. Five
4. Four

2. Upper straight line portion
3. Middle straight line portion
4. Shoulder

5-51. When it has been determined that a point on the log E axis has shifted its position, the cause may be attributed to which of the following factors?
1. A decrease in subject illumination
2. An increase in subject illumination
3. A change in the camera exposure setting
4. All of the above

5-52. The log E range covered by the straight line portion in a characteristic curve is frequently referred to as the region of proportional representation, or the
1. density range
2. total exposure scale
3. useful exposure scale
4. latitude of the emulsion

5-53. Where on a characteristic curve is the lower limit of useful exposure located?
1. In the toe
2. In the shoulder
3. At the snd of the straight line
4. At the beginning of the straight line

5-54. The allowable range of exposures for a given photographic emulsion, scene, and brightness range is referred to as
1. exposure latitude
2. log E range
3. film speed
4. development or density range

5-55. Exposure latitude is directly affected by what two factors?
1. Scene brightness range and the log E range of the straight line portion of the film's characteristic curve
2. The type of photographic developer used to process the film and the length of the straight line portion of the H and D curve
3. Scene brightness range and the negative contrast
4. The type of photographic developer used to process the film and film speed

3. 200
4. 400

5-57. The slope or gradient of the straight line portion of a characteristic curve is determined by the relationship between a given log E interval and which of the following factors?
1. Useful exposure scale
2. Latitude of the material
3. Density range of the material
4. Corresponding density difference

5-58. What range of gamma is desirable in photographic material which is used to record normal subjects?
1. 0.65 to 0.90
2. 1.0 to 1.5
3. 0.6 to 2.4
4. 1.2 to 2.4

5-59. Which of the following terms best applies to the tangent of the angle formed between the straight line portion of a D-log E curve and the log E axis?
1. Alpha
2. Beta
3. Delta
4. Gamma

5-60. What is the gamma of a negative if log $E_1$ - log $E_2$ is equal to 2 and $D_1$ - $D_2$ is equal to 1?
1. 1.0
2. 2.0
3. 3.0
4. 0.5

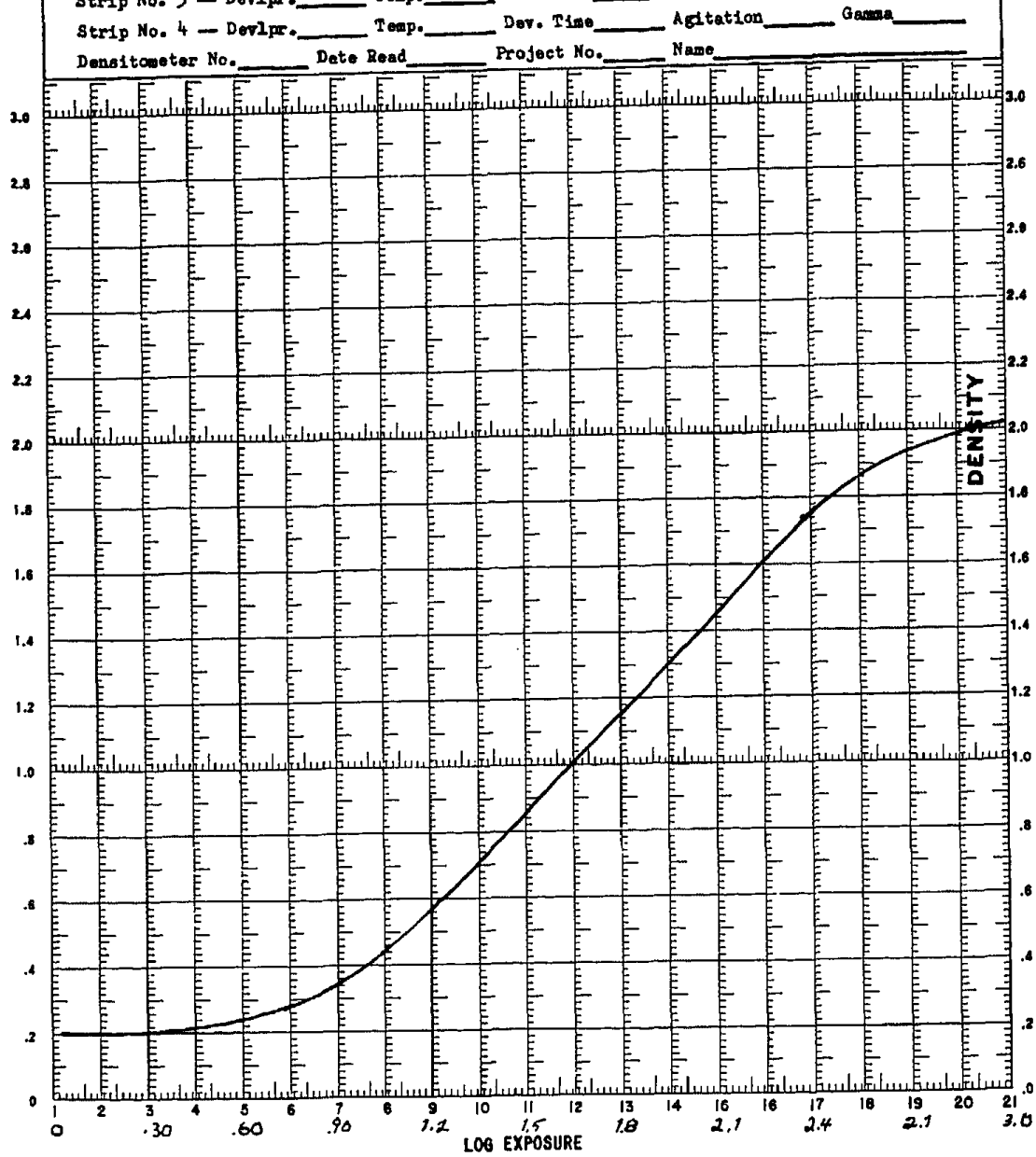


Figure 5A.--Characteristic curve.

● In answering question 5-61, refer to Figure 5A.

5-61. The curve represents what gamma?

1. .60
2. .96
3. 1.15
4. 1.60

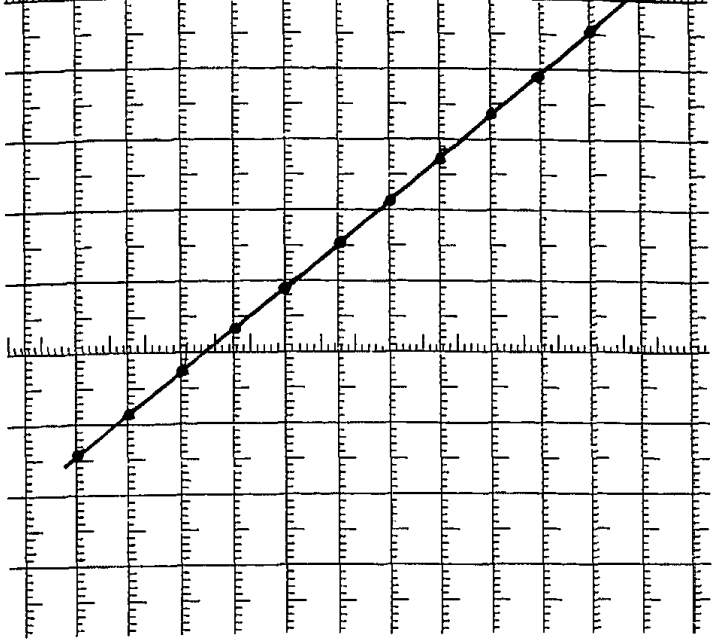

Figure 5B.--Straight line portion of a characteristic curve.

● In answering question 5-62, refer to Figure 5B.

5-62. What gamma is indicated?
1. 0.30
2. 0.60
3. 0.90
4. 1.20

5-63. A negative may contain which of the following types of contrast?
1. Midtone
2. Highlight
3. Shadow
4. All of the above

● Question 5-64 is to be judged True or False.

5-64. Gamma is a measure of negative contrast.

5-65. Other than personal preference, what factor(s) determine(s) the variable contrast filter by which a negative will probably print best?
1. The characteristic curve of the film
2. Scene brightness range and type of photographic developer used
3. Gamma and shadow contrast
4. Total negative contrast

● Question 5-66 is to be judged True or False.

percent when the film is processed.

5-67. Gamma can be considered as the ratio between what factors?
1. Scene brightness range and negative density
2. Scene contrast and negative contrast
3. Scene contrast and negative density
4. The shoulder and the toe of the H and D curve

5-68. When film exposure will extend into the toe region of a D-log E curve, what means of measurement should you use to measure the effects of exposure and development?
1. Contrast index
2. Gamma

● Questions 5-69 and 5-70 are to be judged True or False.

5-69. Processing a roll of film to a constant contrast index will NOT guarantee all of the negatives will have the same total contrast or print similarly with the same printing filter.

5-70. Gamma refers to the slope of the straight line portion of a characteristic curve while contrast index is a measure of the average slope of a characteristic curve.

5-71. Which of the following statements regarding the gamma value of a photographic material is INCORRECT?
1. The gamma value is a fixed value
2. The gamma value is not a fixed value
3. The gamma value fluctuates according to the developer used
4. The gamma value changes according to the method of development employed

5-72. For a specific film, with all other processing factors constant, a difference of gammas indicates differences in
1. exposure
2. latitude
3. light intensity
4. development

5-73. Continuous-tone film of normal photographic subjects should generally be processed to which of the following contrast index values?
1. 0.30
2. 0.58
3. 0.65
4. 0.90

3. time-gamma temperature chart

film to obtain a gamma of 1.0?

1. 5 min
2. 10 min
3. 15 min
4. 20 min

# Assignment 6

Textbook: Pages 2-27 through 2-53

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Learning Objective: Recognize the principles, uses, and advantages of quality assurance procedures in producing high-quality photographic products.

6-1. What is the proper method for determining whether or NOT solutions are within the tolerance allowed for processing?
1. Check for discoloration
2. Watch for sedimentation
3. Check by chemical analysis
4. Each of the above

6-2. Contamination of the chemical solutions used in development can be minimized by which of the following procedures?
1. Wearing rubber gloves while processing
2. Using prescribed methods for cleaning equipment
3. Using filters in the chemical supply lines
4. Never mixing fixer in a mix tank after developer has been mixed in it

6-3. Which of the following QA measures may be applied to chemical mixing?
1. Measuring specific gravity
2. Sensitometric testing
3. Verbal acknowledgment of proper mixing procedures
4. All of the above

6-4. After 120 gallons of fixer has been mixed, approximately what minimum period of time should elapse before chemical analysis is performed?
1. 20 min
2. 40 min
3. 120 min
4. 160 min

6-5. You will be making a quantitative analysis of a developer. How far below the surface of the sample should the pipet opening be when you draw the liquid to be analyzed?
1. 1 inch
2. 2 inches
3. 3 inches

● Question 6-6 is to be judged True or False.

6-6. After drawing a sample of liquid chemical to be analyzed, you should shake the sample and then allow it to settle for 10 minutes.

6-7. Which of the following procedures should normally be taken before a new developer is used?
1. Complete chemical analysis
2. pH testing
3. Specific gravity check
4. Both 2 and 3 above

6-8. When you measure the pH of a solution, the temperature of the solution is most critical if the pH is which of the following values?
1. 1
2. 9
3. 7
4. 4

6-9. When multiple samples of the same solution are to be tested, how often should a pH meter be standardized?
1. Before every reading
2. Every 15 minutes only
3. After four readings only
4. Every 15 minutes and after four readings

6-10. You have taken pH readings of four samples of the same solution. The readings were 6.38, 6.41, 6.47, and 6.71. What pH value should you record on your control chart?
1. 6.44
2. 6.49
3. 6.54

photographic chemical section
3. a pH meter
4. dividing the volume of water by the volume of the chemicals

6-12. If the specific gravity of a solution is above the upper limit determined for that solution, which of the following factors may have caused the reading?
1. The chemicals were not properly diluted
2. More than the formula amount of one or more chemicals was used
3. An ingredient foreign to the solution was added
4. Each of the above

6-13. If the specific gravity of a solution is below the lower limit determined for the solution, which of the following factors may have caused the reading?
1. An excessive amount of water was added to the solution
2. One or more chemicals called for in the formula were left out
3. An ingredient foreign to the solution was substituted
4. Each of the above

6-14. A Photographer's Mate uses pH meters, hydrometers, and sensitometric strips in photographic quality assurance to
1. determine the chemical composition of a solution
2. determine the condition of the photographic process so it can be controlled to obtain repeatable, reproducible results
3. determine the characteristics of a sensitized emulsion
4. assure the photographic officer that the film was properly developed

6-15. Photographic process control charts show the condition of a process through the arrangement of
1. bar graph segments
2. subjective visual aspects
3. numbers
4. objective visual aspects

limits
2. mean, upper, and lower control limits
3. average line, lower, and upper control limits
4. control gamma, below control gamm and above control gamma

6-17. What does the symbol $\overline{D}$ stand for?
1. Average density
2. Average gamma
3. Upper control limit density
4. Below mean density

6-18. Which of the following symbols indica gamma?
1. $\overline{D}$
2. H&D
3. $\gamma$
4. $\Delta$

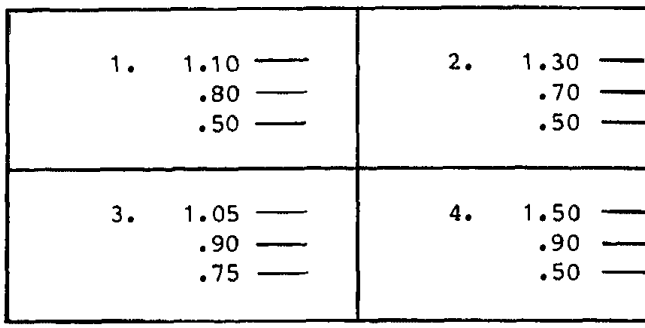


Figure 6A.--Control charts.

In answering questions 6-19 and 6-20, refer to figure--6A.

6-19. Which control chart has the least tolerance for variation?
1. 1
2. 2
3. 3
4. 4

6-20. Which chart(s) should have the contro limits reestablished?
1. Charts 1 and 2 only
2. Charts 2 and 3 only
3. Charts 3 and 4 only
4. Charts 1 through 4

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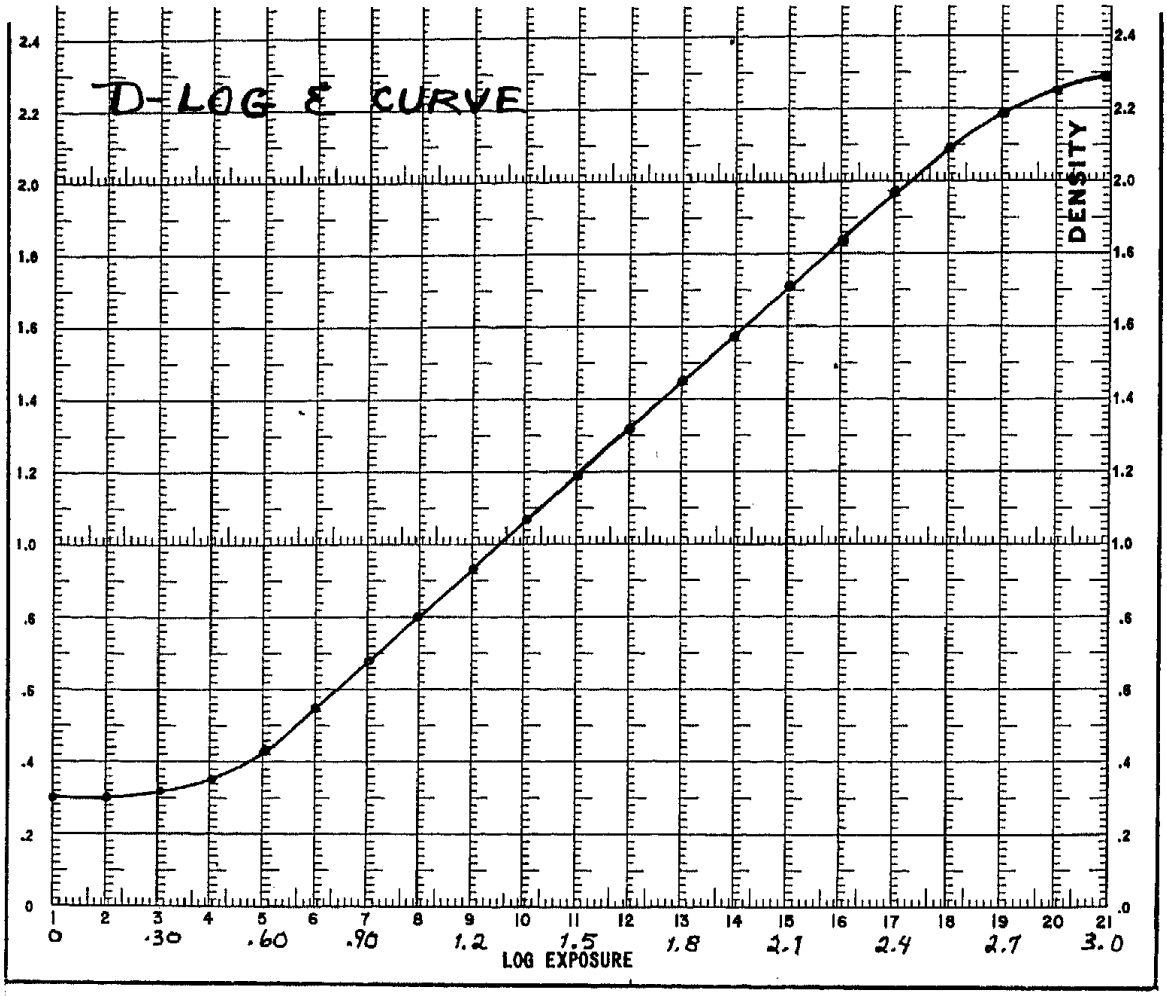
3. Produces 14,000 negatives per month and uses automatic processors for all its production
4. Processes by hand and has a trained QA technician to oversee the production of 6000 negatives per month

2. Excessive agitation
3. Developer temperature too high
4. All of the above



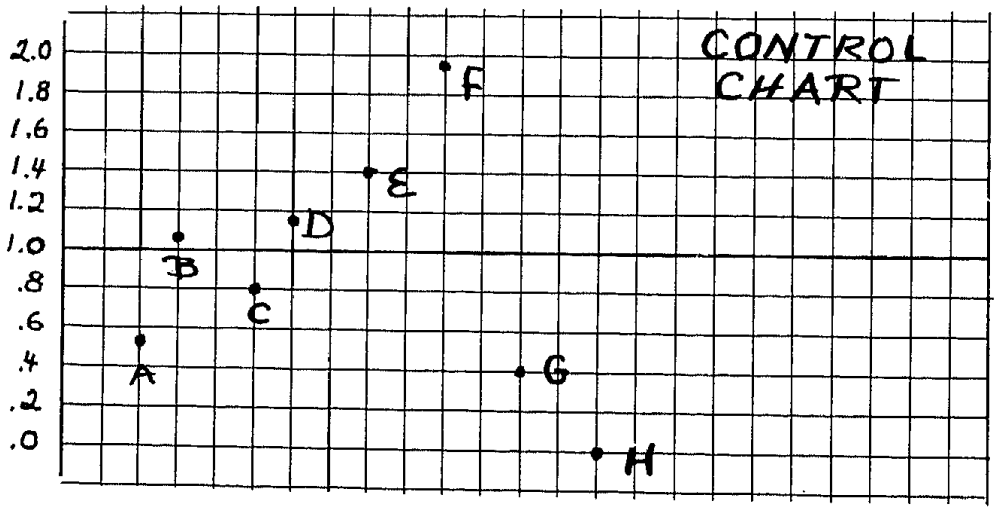




Figure 6B.

6-23. Where should the $\bar{D}$ be plotted on the control chart?

1. A
2. B
3. C
4. E

6-25. Where should high density be plotted?

1. C
2. E
3. F
4. H

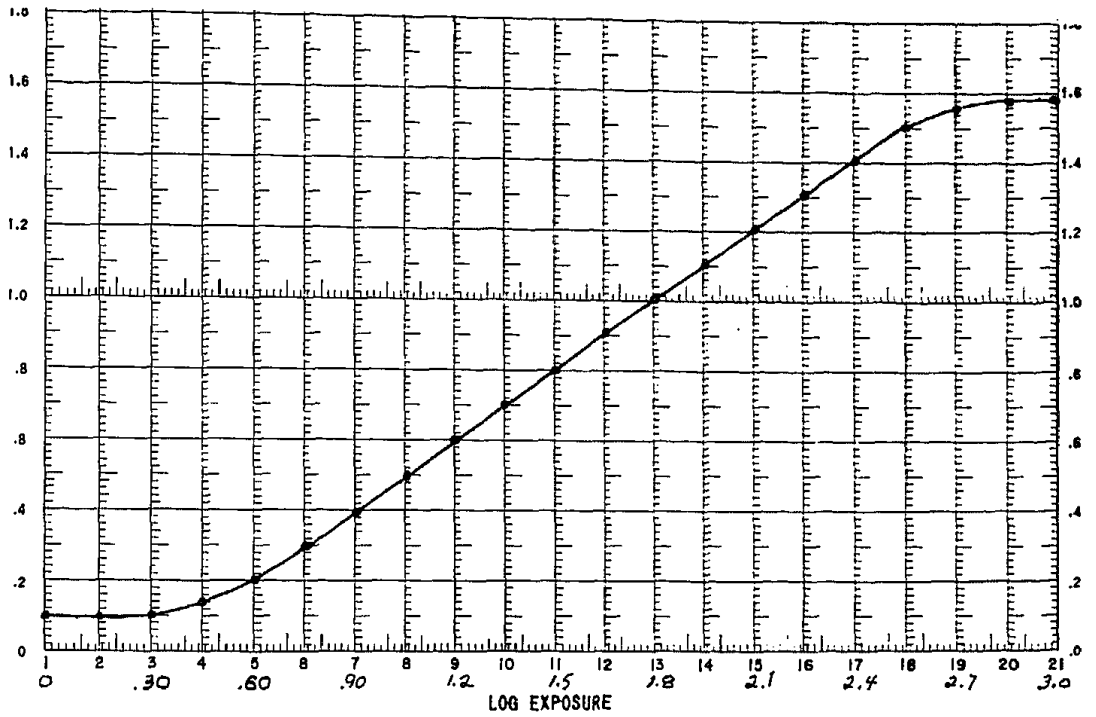



Figure 6C.--H and D curve.

● In answering questions 6-26 and 6-27, refer to figure 6C.

6-26. Which step best represents the speed point for an aerial film?

1. 1
2. 7
3. 5
4. 4

6-27. Which step best represents the speed point for a continuous-tone still picture film?

1. 18
2. 5
3. 3
4. 11

Figure 6D.--Sensi-strip.

- In answering question 6-28, refer to figure 6D.

6-28. From which area of the sensi-strip should the reading for gross fog be made?
1. A
2. B
3. C
4. D

6-29. Which of the following factors will affect gross fog?
1. Film development
2. Film age
3. Film base thickness
4. All of the above

- In answering question 6-30, refer to the control chart on page 2-38 of the text.

6-30. What is the value of the low density of control strip number 7?
1. .10
2. .22
3. .32
4. .40

6-31. A process appears to be out of control but may not be. What is this situation called?
1. Variability
2. Deviation
3. Alpha risk
4. Beta risk

6-32. A process appears to be in control but may not be. What is this situation called?
1. Variability
2. Deviation
3. Alpha risk
4. Beta risk

- Questions 6-33 and 6-34 are to be judged True or False.

6-33. When the alpha risk must be avoided th limit lines are set close to the mean.

6-34. When the beta risk must be avoided the control limits are set close to the average.

6-35. With regard to photographic process control charts, which of the following terms does NOT apply to the amount of variation from the mean?
1. Number set range
2. Standard error
3. Trend
4. Variability

6-36. What are the five process conditions t a control chart can show?
1. Population, variability, deviation standard error, and standard
2. Contrast index, high density, low density, speed point, and gamma
3. Jump, run, trend, out of control, in control
4. Gross fog, pH, temperature, fpm, a contrast

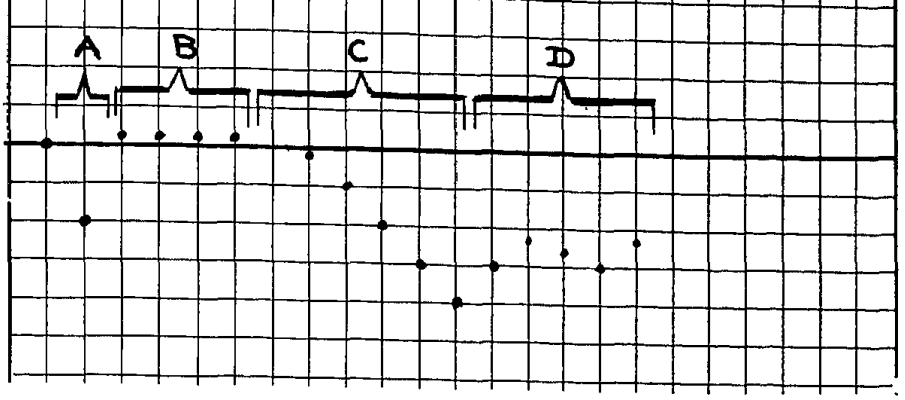



Figure 6E.--Control Chart Plots.

● In answering questions 6-37 through 6-40, refer to figure 6E.

6-37. Which segment represents a jump?
1. A
2. B
3. C
4. D

6-38. Which segment represents a run?
1. A
2. B
3. C
4. D

6-39. Which segment represents a trend?
1. A
2. B
3. C
4. D

6-40. Which segment represents a normal pattern?
1. A
2. B
3. C
4. D

6-41. When a high density control chart plot goes out of control, what action should you take first?
1. Stop the process and change the chemicals
2. Conduct a chemical analysis
3. Check the densitometer
4. Review the chemical mixing records

● In answering question 6-42, refer to the processing record on page 2-45 of the text.

6-42. How many square inches of film were processed on 2/14?
1. 200
2. 575
3. 7320
4. 13,000

6-43. How many tones in a color control strip should be monitored for color QA?
1. 1 or 2
2. 2 or 3
3. 3 or 4

● Question 6-44 and 6-45 are to be judged True or False.

6-44. It is NOT necessary to monitor D-max in a color negative process.

6-45. The manufacturer processes the reference strip which is included with each package of color process control strips?

6-46. At what temperature should color control strips be stored?
1. -10°F
2. 0°F
3. 32°F
4. 68°F

6-47. A color control strip step is read three times. What color densities are read?
1. Red, green, and blue
2. Cyan, magenta, and yellow

2. The maximum density end

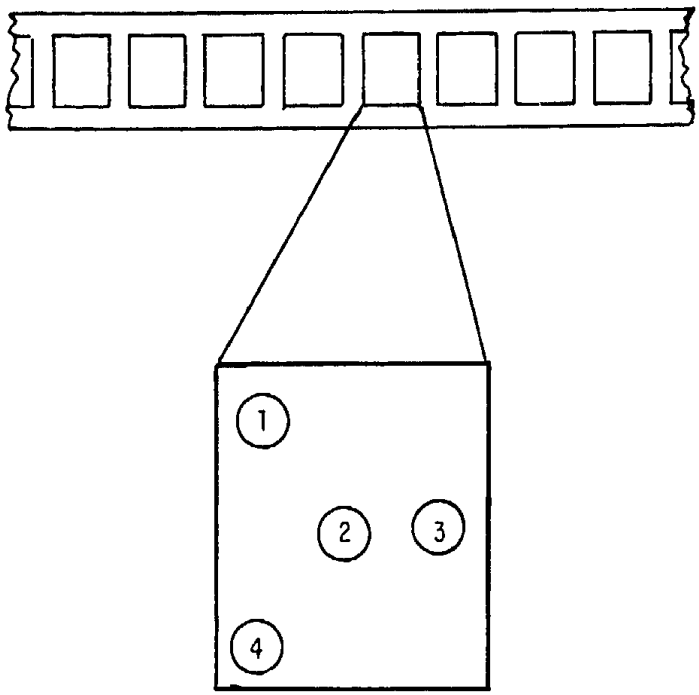



Figure 6F.--Color control strip steps.

and (c) the blue density?
1. (a) 1 (b) 2 (c) 3
2. (a) 2 (b) 3 (c) 4
3. (a) 3 (b) 4 (c) 1
4. (a) 2 (b) 2 (c) 2

6-50. What type of color densitometer shoul you use to read reflection densities?
1. Transmission
2. MM certified
3. Reflection
4. Color control

● Question 6-51 is to be judged True or False.

6-51. On a color process control chart, a p has fallen below the lower action lim but is within the control limit. The process should be stopped.

6-52. When the control limits on a color process control chart have been excee what is the last corrective action yo should take?
1. Perform a bypass test
2. Change the chemistry
3. Reread the control strip
4. Run another control strip

Tactical Air Photographic Reconnaissance

Textbook: Pages: 3-1 through 3-36

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Learning Objective: Identify the various types of aerial photographic missions and state the advantages of proper mission planning. Provide flight crews with information such as altitude, camera, lens focal length, time interval, and aircraft speed necessary for them to successfully accomplish aerial photographic missions.

7-1. What was the most important mission of World War I Navy pilots?
1. Watching the enemy
2. Aerial photography only
3. Post-mission photographic bomb damage assessment
4. Covert aerial photography of overt operations

● Question 7-2 is to be judged True or False.

7-2. During WWI most intelligence was gathered through aerial photography.

7-3. Which of the following intelligence "systems" is the primary way a naval commander gets up-to-date information about the area where his task force is operating?
1. Radio monitoring
2. "Underground" spies
3. Aerial surveillance
4. Personal observation

7-4. Which of the following aircraft provides the Navy with its most sophisticated aerial photographic capability?
1. A-3D
2. RA-5C
3. F-4
4. F-14

7-5. The TARPS contains a maximum of how many sensors?
1. One
2. Two
3. Three
4. Four

7-6. The TARPS provides what type of photography as primary day reconnaissance?
1. Panoramic
2. Serial frame
3. Infrared

7-7. To obtain forward oblique photography, what type of camera is used in the TARPS?
1. Panoramic
2. Frame
3. Infrared

7-8. What official normally originates a requirement for EEI reconnaissance?
1. The Commander, Naval Intelligence
2. The Secretary of the Navy
3. A special intelligence collector
4. A task force commander

7-9. What official usually assigns TARPS missions to a given squadron?
1. The air wing commander
2. The task force commander
3. The Chief of Naval Operations
4. The Secretary of the Navy

7-10. What class of Navy ship has a carrier-based intelligence center?
1. LPH
2. CV
3. CG
4. CA

3. Film processing
4. Each of the above

● Question 7-12 is to be judged True or False.

7-12. According to page 3-6 of the text, a reconnaissance planning board will consist of at least 10 persons, one of which will be a senior PH.

7-13. Generally speaking, what member of a reconnaissance mission planning board selects the sensors to be used?
1. Photographic officer
2. Squadron operations officer
3. Reconnaissance coordinator
4. Squadron air intelligence officer

7-14. Generally speaking, what member of a reconnaissance mission planning board selects the type of film to be used?
1. Pilot
2. Photographic officer
3. CVIC supervisor
4. Reconnaissance coordinator

● Question 7-15 is to be judged True or False.

7-15. As far as aerial photographic reconnaissance is concerned, a mission planning form is used only with the TARPS.

7-16. What document provides CVIC personnel with the information necessary to make preparations for processing TARPS film?
1. Mission Planning Form
2. Maintenance Action Form
3. Audiovisual Activity Job Order

7-17. Which of the following divisions is responsible for the preparation of TARPS sensors for a mission?
1. Photo lab
2. CVIC
3. Line maintenance
4. Mission planning

3. CVIC
4. Photo lab

7-19. What does ℓ/mm stand for?
1. Lines per millimeter
2. 1 millimeter
3. Dynamic resolution
4. Image quality

7-20. Which of the following factors has a bearing on dynamic resolution as it applies to TARPS imagery?
1. Weather condition
2. Film type
3. Camera lens quality
4. Each of the above

7-21. A film with which of the following speeds is capable of providing the greatest resolution?
1. 100
2. 200
3. 300
4. 400

7-22. Vibrations of the TARPS will least affect the resolution of a film with which of the following speeds?
1. 100
2. 200
3. 300
4. 400

7-23. A given film type will probably have the greatest resolution if it has what contrast value?
1. Low
2. Average
3. High

7-24. Which of the following factors can have a bearing on the negative contrast of TARPS film?
1. Weather
2. Camera filters
3. Film processing
4. Each of the above

7-25. TARPS film shot from an altitude of 37,000 feet of a low contrast target should probably be processed to which of the following gammas?
1. 0.56
2. 0.66
3. 0.76
4. 0.86

2. 4000 feet
3. Both 1 and 2 above
4. 17,000 feet

7-27. Black and white film used in the TARPS can reproduce about (a) how many gray tones while color film can record about (b) how many hues?
1. (a) 267 (b) 30
2. (a) 256 (b) 128
3. (a) 128 (b) 256
4. (a) 30 (b) 267

● Question 7-28 is to be judged True or False.

7-28. Without being specific, the information given in the text indicates that with the TARPS three sensors can be used at the same time.

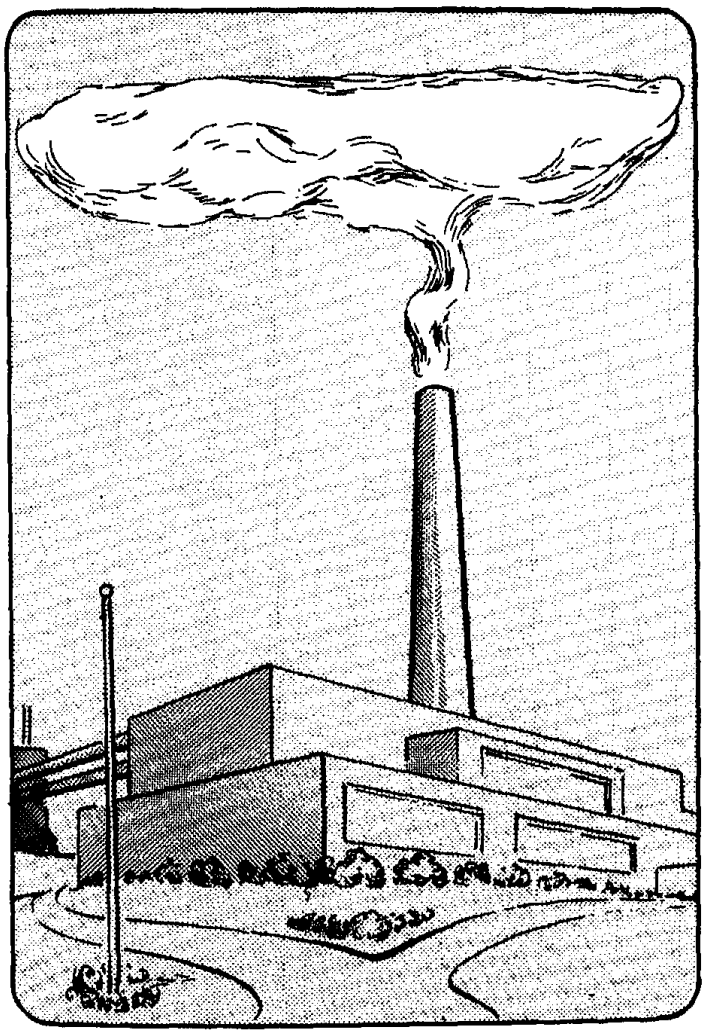

Figure 7A.--Smoke rising from a powerplant.

by the rising smoke?
1. Thermal shimmer
2. Temperature inversion
3. Smog
4. Haze

7-30. To make a forward oblique photograph of a target early in the morning, which of the following aircraft headings should NOT be used?
1. 090°
2. 180°
3. 205°
4. 350°

7-31. To obtain target information when the sun angle is less than 20°, it would probably be advisable to use which of the following TARPS sensors?
1. Frame camera
2. Pan camera
3. IRRS

7-32. On a bright sunny day, heat emission from the earth's surface is greatest at which of the following times?
1. 1200
2. 1500
3. 1800

7-33. Using the TARPS, what type of photography is usually performed after sunset?
1. Flash bomb
2. Flash cartridge
3. IR
4. Panoramic

● Question 7-34 is to be judged True or False.

7-34. Because of the very low temperature, IR photography over the Antarctic is not possible.

7-35. What is the first step in selecting an image sensor for aerial reconnaissance photography?
1. Learn what sensors are available
2. Determine the amount of film needed
3. Understand the mission requirements
4. Find out the number of aircraft available

3. 1/2 mile
4. 3/4 mile

7-37. What is the scale of an image of a target shot from an altitude of 10,000 feet with a camera equipped with a 3-inch lens?
1. 1:10,000
2. 1:20,000
3. 1:30,000
4. 1:40,000

7-38. What is the scale of a photograph taken from a height of 4700 feet with a 5-inch lens?

1. $\frac{1}{11,280}$

2. 1:11,280

3. 1/11,280

4. Each of the above

In answering questions 7-39 through 7-52, use the following information.

a. An area to be photo mapped is 15 nautical miles north and south by 25 nautical miles east and west.

b. Forward overlap is to be 60 percent, sidelap 40 percent.

c. Photography scale is to be 1:17,000.

d. Camera lens focal length is 7 inches, film format 4.5 x 4.5 inches.

e. Aircraft airspeed 320 knots, there is no wind.

f. Ground coverage per shot is 6400 feet.

g. Mission planning chart scale is 1:40,500.

7-39. From what altitude should the photography be shot?
1. 5950 feet
2. 10,000 feet
3. 23,800 feet
4. 9955

7-41. The image of a building on the film measures 1.75 inches long. What is the actual length of the building?
1. 1452 feet
2. 2489 feet
3. 3750 feet
4. 4800 feet

7-42. With the required overlap, what is the GGF?
1. 640 feet
2. 1280 feet
3. 2560 feet
4. 5120 feet

7-43. With the required overlap, what is the GGS?
1. 1840 feet
2. 2840 feet
3. 3840 feet
4. 4840 feet

7-44. In which direction should the aircraft be flown?
1. North only
2. North or south
3. East only
4. East or west

7-45. The area to be photographed is (a) how many feet long and (b) how many feet wide?
1. (a) 152,000 (b) 91,200
2. (a) 262,000 (b) 92,400
3. (a) 362,000 (b) 93,800
4. (a) 462,000 (b) 94,600

7-46. How many photographs will be required per flight strip?
1. 59
2. 60
3. 64
4. 66

7-47. How many flight strips are required?
1. 15
2. 25
3. 35
4. 45

7-48. How many pictures are required?
1. 1600
2. 2600
3. 3600
4. 4600

2. 2.26 inches
3. 3.72 inches
4. 4.40 inches

7-50. What should be the interval between exposures?

1. 1.1 sec
2. 2.3 sec
3. 3.5 sec
4. 4.7 sec

2. (a) 214 in. (b) 128 in.
3. (a) 428 in. (b) 256 in.
4. (a) 856 in. (b) 512 in.

7-52. How many inches on the mosaic will represent 1000 feet on the ground?

1. 0.70
2. 0.90
3. 1.10
4. 1.30

Textbook: Pages 3-37 through 3-57

Learning Objective: Provide flight crews with information such as altitude, camera, lens focal length, time interval, and aircraft speed, necessary for them to successfully accomplish aerial photographic missions. Recognize the senior PH's responsibility for the processing of aerial reconnaissance film.

● Question 8-1 is to be judged True or False.

8-1. Because aerosols in the atmosphere are, for practical purposes, nonexistent above a 30,000-foot altitude, photographs made from an altitude of 47,000 feet will not be affected by atmospheric conditions.

8-2. You are planning a mission for medium altitude aerial photography over land and don't know the atmospheric conditions. Which of the following filters should you probably install on the camera for (a) normal black and white photography and (b) CDIR photography?
1. (a) 25 (b) HF-3
2. (a) 25 (b) 12
3. (a) 12 (b) 25
4. (a) 12 (b) 12

8-3. An HF-3 filter has which, if any, of the following filter factors?
1. One
2. Two
3. Three
4. None of the above

8-4. Black and white panchromatic aerial films are sensitive to what colors and/or wavelengths of light?
1. Red, green, and blue
2. Red, blue, and ultraviolet
3. Green, blue, and ultraviolet

8-5. Black and white infrared aerial films are sensitive to what colors and/or wavelengths of light?
1. Red, green, and infrared
2. Red, blue, and infrared
3. Red, green, and blue
4. All of the above

8-6. All three emulsion layers of CDIR film are sensitive to what color(s) of light?
1. Red
2. Green only
3. Blue only
4. Blue and green

8-7. When an IR color film is processed to a transparency, images of what color are formed of subjects that reflect (a) infrared radiation, (b) green light, and (c) blue light?
1. (a) Red (b) blue (c) black
2. (a) Black (b) green (c) blue
3. (a) White (b) red (c) green
4. (a) Blue (b) yellow (c) red

8-8. The processing standards for an aerial film are not specified by the ANSI. What type of film speed will be assigned to this film?
1. ASA
2. ISO
3. AFS
4. EAFS

(a) minimum and (b) maximum deep shadow densities?

1. (a) 0.05 (b) 0.25
2. (a) 0.25 (b) 3.18
3. (a) 0.23 (b) 0.43
4. (a) 0.53 (b) 0.95

8-10. Which of the following mission planning documents are based on camera distance above terrain and field of view only?

1. Angular Ground Coverage Charts
2. Linear Ground Coverage Charts
3. Operational Limits Charts
4. Nadir Point Fore/Aft Charts

8-11. Which of the following times of day should be avoided for infrared aerial photography?

1. Late evening
2. Midafternoon
3. Noon
4. Early morning

8-12. During a nighttime IR photo mission, the clouds are forecast to be at an altitude of 6800 feet. At which of the following altitudes should the aircraft be flown?

1. 5800 feet
2. 6800 feet
3. 7800 feet
4. 8800 feet

8-13. Which, if any, of the following types of day will ALWAYS result in the best IR recon photography?

1. Windy
2. Overcast
3. Clear
4. None of the above

● Question 8-14 is to be judged True or False.

8-14. Rain, fog, and snow do not have an effect on IR image quality.

8-15. Information as to film processing requirements for an aerial photo reconnaissance mission are given in which of the following documents?

1. Mission Planning Form
2. Film Processing Record TARPS-30
3. CVIC Family of Curves Chart
4. Camera Exposure/AFS/Processing Quality Form

1. Processing solution condition
2. Processing temperature
3. Replenishment rate
4. Each of the above

8-17. What is the second step which must be followed to ensure quality reconnaissance photography processing?

1. Identify the process specifications
2. Evaluate the process
3. Perform chemical analysis
4. Diagnose troubles

8-18. Which of the following factors may affect processed image quality?

1. Camera mounting
2. Shutter speed
3. Light intensity
4. Each of the above

● Question 8-19 is to be judged True or False.

8-19. The best image results for a given film can only be obtained when the film manufacturer's process specifications are followed.

8-20. For which of the following factors might you consider maintaining a control chart?

1. AFS
2. EAFS
3. Gross fog
4. Each of the above

8-21. Making sure that your densitometer is operating correctly is part of what reconnaissance mission step?

1. Post-mission
2. Mission processing
3. Pre-mission
4. Execution

● Question 8-22 and 8-23 are to be judged True or False.

8-22. Reconnaissance film should be inspected for physical defects only after processing to prevent accidently exposing the film to white light.

8-23. After starting to process reconnaissance film in an EH-38D, the developer temperature can be altered.

4. 4 inches

8-25. To prevent film from being scratched in a roller transport friction drive film processor, you may use which of the following methods?
1. Completely thread the processor with leader to which the film is attached
2. Run the film through the processor emulsion side up
3. Run the film through the processor emulsion side down
4. Pretreat the film in a hardening bath

8-26. What type of QA instrument is used to determine image resolution of processed aerial reconnaissance film?
1. Densitometer
2. Sensitometer
3. Microscope
4. Gamma gage

3. Both 1 and 2 above
4. Specific tone reproduction

● Questions 8-28 and 8-29 are to be judged True or False.

8-28. The 1.0 print gamma reproduction method is an objective method of producing duplicate negatives.

8-29. The trigradient tone reproduction method is an objective method of producing duplicate transparencies.

Textbook: Pages 4-1 through 4-33

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Learning Objective: Identify the types of specialized photography senior PHs may be required to perform, supervise, evaluate, or teach to photographic and nonphotographic personnel.

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● Questions 9-1 and 9-2 are to be judged True or False.

9-1. All graduates of the Schools of Naval Photography must demonstrate a proficiency in underwater photography.

9-2. A Canon F-1 camera in an underwater camera housing has less buoyancy than a Nikonos camera.

9-3. What are the two primary types of lens ports for underwater camera housings?
1. Flat and dome
2. Flat and sea
3. Dome and sea

9-4. Which of the following focal length lenses is least desirable for underwater use when it is enclosed in a flat lens port underwater camera housing?
1. 21mm
2. 35mm
3. 50mm
4. 90mm

9-5. When an underwater subject is viewed through an SLR enclosed in a flat lens port camera housing, the subject appears to be 10 feet from the camera. What is the approximate camera-to-subject distance?
1. 6 ft
2. 8 ft
3. 10 ft
4. 12 ft

● Question 9-6 is to be judged True of False.

9-6. Focusing a camera enclosed in a dome lens port underwater housing should be performed using the vernier focusing scale.

9-7. Which of the following focal length lenses used on a 35mm camera is most suitable for underwater photography?
1. 35mm
2. 50mm
3. 90mm
4. 75 to 180 zoom

9-8. When a 50mm lens is used for underwater photography, what is its approximate effective focal length?
1. 35mm
2. 47mm
3. 66mm
4. 82mm

9-9. The O-rings in underwater photo equipment should be changed at least how often?
1. Monthly
2. Quarterly
3. Semiannually
4. Annually

● Question 9-10 is to be judged True or False.

9-10. O-rings should not be removed from a flooded camera prior to soaking it in fresh water.

9-11. After a flooded camera has been immersed in fresh water, how long should it be treated in alcohol?
1. 10 min
2. 20 min
3. 30 min
4. 40 min

underwater photography?
1. 1000
2. 1200
3. 1400
4. Each of the above

9-13. Which of the following times of day and conditions generally presents the best available light for underwater photography?
1. 1000 on a bright, windy day
2. 1000 on an overcast, calm day
3. 1400 on an overcast, windy day
4. 1400 on a bright, calm day

9-14. The least amount of refraction by the water surface occurs when the sun is in what position?
1. High
2. Low

9-15. During what time of year will the water off the coast of Maine be clearest?
1. Spring
2. Summer
3. Fall
4. Winter

9-16. Which of the following colors of light is absorbed most by water?
1. Blue
2. Green
3. Red

● Questions 9-17 through 9-19 are to be judged True or False.

9-17. As in still ground photography, film exposure for available light underwater photography is not dependent on camera-to-subject distance.

9-18. The best color photography of underwater subjects will be obtained when the photography is performed in shallow water from a close camera-to-subject distance.

9-19. On a bright, calm day, the f/16 rule of exposure applies to underwater photography between the hours of 1000 to 1400 only.

9-20. The best way to calculate underwater photography exposure is to
1. use the f/16 rule
2. refer to the film data sheet
3. use an exposure meter

1. Yellow only
2. Red and yellow
3. Blue and green
4. Red only

9-22. Which of the following filters is recommended for increasing photographic contrast in underwater black and white photography?
1. No. 61
2. No. 48
3. No. 25
4. No. 12

9-23. Which of the following film ISOs would most appropriate to use underwater for available light on a cloudy, dark, and windy day at about 1500?
1. 200
2. 150
3. 125
4. 75

9-24. Using natural light, what type of color film is recommended for underwater photography?
1. Daylight
2. Tungsten

9-25. Which of the following CC filters shoul you consider using over an electronic flash for underwater photography?
1. 20Y
2. 30G
3. 40R
4. 50B

9-26. If the actual temperature is -10°F and there are 5 knots of wind blowing, what is the approximate effective temperatur
1. 15°F
2. 10°F
3. -10°F
4. -15°F

9-27. Which of the following types of light i present during a whiteout?
1. Specular
2. Refracted
3. Diffused

9-28. When photographic equipment has been properly winterized you can expect it t operate well down to what minimum temperature?
1. 0°F
2. -30°F
3. -65°F
4. -128°F

3. Gasoline
4. None of the above

9-30. A 35mm SLR should be cold-soaked for a minimum of how many hours before being used at a temperature of -65°F?
1. 6
2. 12
3. 24
4. 48

9-31. When the outside temperature is -22°F, the most suitable temperature for an intermediate room would be which of the following?
1. -10°F
2. -30°F
3. 30°F
4. 50°F

9-32. The environment of which region will be most damaging to photographic equipment?
1. Polar
2. Tropical

● Question 9-33 is to be judged True or False.

9-33. In the tropics, all photographic equipment and materials must be stored in heated cabinets to prevent the growth of mold.

9-34. How frequently should you clean a camera used in the tropics?
1. Daily
2. Weekly
3. Monthly
4. After each use

9-35. Film which is assigned ISO 125 should be rated at what ISO when used in the tropics?
1. 125
2. 250
3. 500
4. 1000

9-36. In the tropics, daylight lighting contrast is generally
1. high
2. low
3. normal

9-37. In the tropics, photographic print files should be maintained at about what relative humidity?
1. 20 percent
2. 45 percent
3. 60 percent
2. Hypo
3. Film cleaner

● Questions 9-39 and 9-40 are to be judged True or False.

9-39. Regular desiccant will turn pink when it is full of moisture.

9-40. High-speed motion picture photography is photography generally shot at 24 fps of very fast-moving subjects.

9-41. Usually, a motion picture shot at 7000 fps should be viewed at what projection fps rate?
1. 7000
2. 3500
3. 24
4. 6

9-42. What minimum fps rate is considered high-speed mopic photography?
1. 24
2. 72
3. 100
4. 128

9-43. What term is used to describe motion pictures shot at (a) 72 fps and (b) 128 fps?
1. (a) High speed (b) high speed
2. (a) High speed (b) time magnification
3. (a) Slow motion (b) slow speed
4. (a) Slow motion (b) time magnification

9-44. The picture taking fps rate was 472 and the projection rate is 24 fps. What is the time magnification?
1. 3:1
2. 9:1
3. 12:1
4. 19:1

9-45. An event which took 12.7 seconds was photographed at 1150 fps. How long will the screen action last when the film is projected at 18 fps?
1. 1.06 sec
2. 76.0 min
3. 63.0 sec
4. 13.5 min

9-46. Which of the following fps rates is about the maximum for an intermittent action, high-speed mopic camera?
1. 124
2. 248
3. 372
4. 496

4. Ultrahigh-speed

9-48. As a general rule, which high-speed camera operates at the highest fps rate?
1. Pin registration
2. Rotating prism

9-49. One thousand feet of 16mm film shot at 1312 fps can be used to photograph action that lasts a maximum of how many seconds?
1. 10
2. 20
3. 30
4. 40

9-50. When time-lapse photography is shot at 1.5 fps (a) what total number of frames can be shot per minute, (b) a maximum of how many minutes of action can be photographed on 500 feet of 16mm film and (c) what is the projection time in minutes at 24 fps?
1. (a) 10 (b) 63 (c) 6
2. (a) 20 (b) 125 (c) 8
3. (a) 30 (b) 250 (c) 10
4. (a) 40 (b) 500 (c) 14

9-51. An action to be recorded with time-lapse photography will last 6.5 hours. Your fps rate is to be 3. How many feet of 16mm film will be required to film the action?
1. 1755
2. 3510
3. 7020
4. 8040

9-52. If the action is to last 47 minutes and the viewing time is to be .5 minutes at a projection rate of 24 fps, what would be the fps rate for time-lapse photography?
1. 1.9
2. 2.9
3. 3.9
4. 4.9

9-53. If the action is to last 11,100 seconds and must be photographed on 120 feet of 16mm film, what would be the fps rate for time-lapse photography?
1. 1.3
2. 2.3
3. 3.3
4. 4.3

3. 344
4. 444

9-55. In a time-lapse movie, 12,830 frames were used to record the action. When the film is projected at standard fps rate what will be the screen time?
1. 1.5 min
2. 3.5 min
3. 6.0 min
4. 9.0 min

● Question 9-56 is to be judged True or False.

9-56. Cutaway models can be used to make animated film.

9-57. What is the maximum number of drawings that may be required to produce a 3-minute, 16mm animated film?
1. 1440
2. 1080
3. 2160
4. 4320

9-58. Which of the following cameras is most appropriate for shooting pictures thro a pair of binoculars?
1. Double frame 35mm 3-D
2. 4x5 view
3. 2 1/4 rangefinder
4. 35mm SLR

● Use the following information to answe questions 9-59 and 9-60.

Camera lens focal length - 90mm
Camera lens speed - 2.8
Binocular power - 10
Binocular objective lens size - 75m

9-59. What is the system's approximate effec f/number?
1. 5.6
2. 8
3. 11
4. 16

9-60. What is the system's effective focal length?
1. 165mm
2. 825mm
3. 900mm
4. 1900mm

3. Low

9-62. The camera you are using for CRT photography requires a shuttle speed of 1/30 for electronic flash synchronization. What is the maximum shutter speed you can use to photograph the display on a CRT?
1. 1/15
2. 1/30
3. 1/60
4. 1/125

9-63. The CRT display is red. You should use what type of film to photograph the display?
1. Monochromatic
2. Orthochromatic
3. Panchromatic

9-64. The CRT you are photographing is designated P11. What type of film is suitable for the photography?
1. Monochromatic
2. Orthochromatic
3. Panchromatic
4. Each of the above

9-65. If you had to select only one developer to process all of your black and white CRT photography, which of the following developers should you select?
1. D-10
2. D-19
3. DK-50
4. D-72

● Question 9-66 is to be judged True or False.

9-66. The only subjects suitable for periscope photography are ships at sea.

9-67. What is the main objective of a submarins engaged in covert surveillance photography of a ship?
1. Avoiding counterdetection
2. Obtaining quality photography
3. 90 degrees to back

9-69. What amount of spacing should there be between identical image points on a pair of photos mounted for stereoscope?
1. 1.26 in.
2. 2.33 in.
3. 3.32 in.
4. 4.75 in.

● Question 9-70 is to be judged True or False.

9-70. In order to produce a stereoscopic effect, two photographs must overlap 60 percent.

9-71. For periscope photography, film exposure is primarily controlled with which camera adjustment?
1. Shutter
2. Aperture

9-72. You are using ISO 500 film for periscope photography. What is your basic shutter speed?
1. 1/125
2. 1/250
3. 1/500
4. 1/1000

9-73. Which of the following publications should you consult for information on the operation of the KG-29A Type 18 periscope camera?
1. NAVEDTRA 373-02-45-83
2. NWP 79-2, NAVAIR 10-1-798
3. OPNAVINST 5290.1
4. NAVAIRINST 10700.1

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| 35 | ☐ | ☐ | ☐ | ☐ |
| 36 | ☐ | ☐ | ☐ | ☐ |
| 37 | ☐ | ☐ | ☐ | ☐ |
| 38 | ☐ | ☐ | ☐ | ☐ |
| 39 | ☐ | ☐ | ☐ | ☐ |
| 40 | ☐ | ☐ | ☐ | ☐ |
| 41 | ☐ | ☐ | ☐ | ☐ |
| 42 | ☐ | ☐ | ☐ | ☐ |
| 43 | ☐ | ☐ | ☐ | ☐ |
| 44 | ☐ | ☐ | ☐ | ☐ |
| 45 | ☐ | ☐ | ☐ | ☐ |
| 46 | ☐ | ☐ | ☐ | ☐ |
| 47 | ☐ | ☐ | ☐ | ☐ |
| 48 | ☐ | ☐ | ☐ | ☐ |
| 49 | ☐ | ☐ | ☐ | ☐ |
| 50 | ☐ | ☐ | ☐ | ☐ |
| 51 | ☐ | ☐ | ☐ | ☐ |
| 52 | ☐ | ☐ | ☐ | ☐ |
| 53 | ☐ | ☐ | ☐ | ☐ |
| 54 | ☐ | ☐ | ☐ | ☐ |
| 55 | ☐ | ☐ | ☐ | ☐ |
| 56 | ☐ | ☐ | ☐ | ☐ |
| 57 | ☐ | ☐ | ☐ | ☐ |
| 58 | ☐ | ☐ | ☐ | ☐ |
| 59 | ☐ | ☐ | ☐ | ☐ |
| 60 | ☐ | ☐ | ☐ | ☐ |
| 61 | ☐ | ☐ | ☐ | ☐ |
| 62 | ☐ | ☐ | ☐ | ☐ |
| 63 | ☐ | ☐ | ☐ | ☐ |
| 64 | ☐ | ☐ | ☐ | ☐ |
| 65 | ☐ | ☐ | ☐ | ☐ |
| 66 | ☐ | ☐ | ☐ | ☐ |
| 67 | ☐ | ☐ | ☐ | ☐ |
| 68 | ☐ | ☐ | ☐ | ☐ |
| 69 | ☐ | ☐ | ☐ | ☐ |
| 70 | ☐ | ☐ | ☐ | ☐ |
| 71 | ☐ | ☐ | ☐ | ☐ |
| 72 | ☐ | ☐ | ☐ | ☐ |
| 73 | ☐ | ☐ | ☐ | ☐ |
| 74 | ☐ | ☐ | ☐ | ☐ |
| 75 | ☐ | ☐ | ☐ | ☐ |